PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

The *node* at the top of this Hortonspheroid is significant to anyone who stores volatile hydrocarbons. Such hydrocarbons require pressure storage to reduce evaporation losses. Because of the noded design, the Hortonspheroid offers you the *greatest selection* of sizes and pressures when you're storing products like natural gasoline, butane, and high-vapor pressure naphtha.

You can get the right tank by selecting a Hortonspheroid.

Bulletin E tells about other Hortonspheriod advantages such as reducing the fire hazard. Write for a copy.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles
New York • Philadelphia • Salt Lake City • San Francisco • Tulsa • Washington

"HOTTER, SOONER"

Saves YOU MONEY

Yarway Impulse Steam Trap with new stainless steel body.

Yarway Impulse Steam Traps get equipment hot and into production *faster*. Extra profits!

Then they keep it *continuously* at peak operating temperatures for maximum production. More extra profits!

What's the reason for *hotter, sooner?* Just this. When steam is turned on, Yarways open wide, discharging the air and condensate *in a hurry* —closing only when steam arrives. Then, when operating temperature has been quickly reached, the little valve (only moving part) literally *floats on the load*... discharging heat-retarding condensate as soon as it forms instead of waiting for quantities to accumulate. Thus equipment is held at peak operating efficiency.

Other economical features of Yarway traps—minimum maintenance, easy installation, low initial cost.

More than 600,000 Yarways have already been installed. Sold by distributors throughout the world.

Try a Yarway today... standardize on Yarways tomorrow.

YARNALL-WARING COMPANY
128 MERMAID AVENUE, PHILA. 18, PA.

Nest of Yarway traps installed with Yarway Strainers on cloth dryer. Note small space required.

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

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Let PETROLEUM REFINER keep your key men informed of the latest developments in processing. Special rates for company group subscriptions.

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President — A. L. BURNS, General Manager
VOLUME 30, No. 4 — APRIL, 1951

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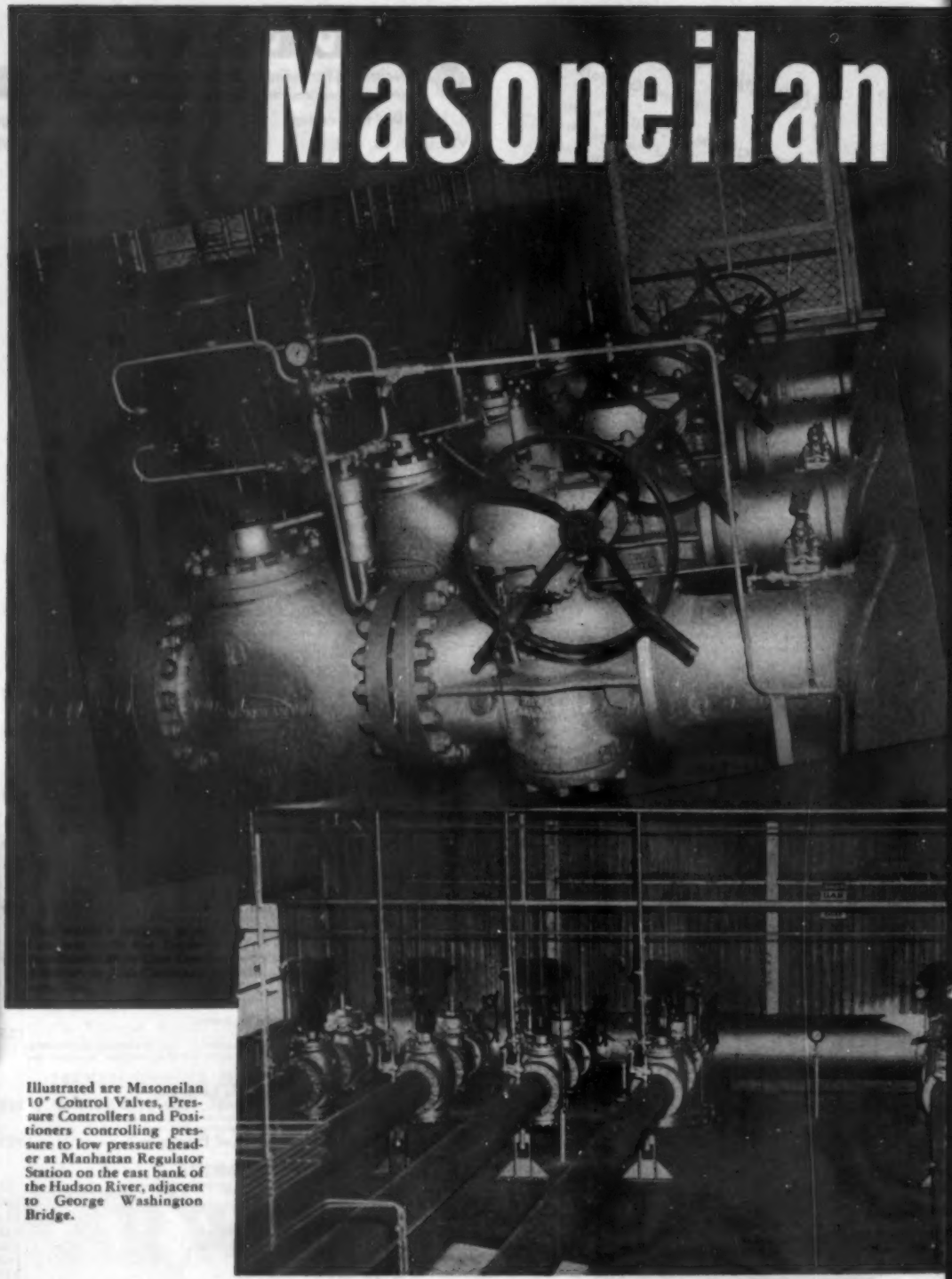
Masoneilan



Illustrated are Masoneilan 10" Control Valves, Pressure Controllers and Positioners controlling pressure to low pressure header at Manhattan Regulator Station on the east bank of the Hudson River, adjacent to George Washington Bridge.

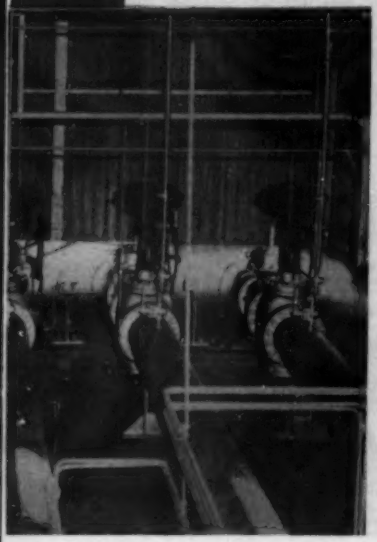
Control Valves

at Manhattan Terminal of Transcontinental Pipe Line

Deliver New York City's First Natural Gas

After flowing three to four days through over 1800 miles of 30-inch pipe, 250 million cubic feet per day of Texas-Louisiana natural gas is delivered to the eastern seaboard for distribution in New York City . . . the longest pipe line in the world is in operation.

Masoneilan 10-inch Series 10,000 Control Valves, operated by Masoneilan Model 2707 Pressure Controllers and Masoneilan Series 7400 Positioners, control the gas pressure at the Manhattan and Linden, N. J. terminal stations. A portion of the gas controlled by these Masoneilan Valves at the Linden terminal is destined for eventual distribution to New England.



The preference for Masoneilan Control Valves among pipe line builders and operators is recognition of quality which has been endorsed by the selection of Masoneilan Valves for the major pipe lines of the world.

If your responsibilities include control valve selection for *any* industrial use, compare Masoneilan Valves with any others.

Quality Characteristics Make Masoneilan Control Valves Outstanding

MASON-NEILAN REGULATOR CO.
1102 ADAMS STREET, BOSTON 24, MASS., U.S.A.

MASONEILAN

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago St. Louis • Philadelphia • Houston • Denver • Pittsburgh • Cleveland • Cincinnati Tulsa • Atlanta • Los Angeles • San Francisco • Salt Lake City • El Paso Boise • Albuquerque • Detroit • Charlotte, N.C. Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

Looking for tubes with a better life/cost ratio? Ask the experts!

This month's report is on: **SILMO**

Offers good combination of high temperature strength and oxidation resistance. At 1000°F. — 1150°F., it has about twice the strength of carbon steel and oxidation resistance comparable to 4-6 Cr. Mo. For use in cracking furnace, heater, high pressure boiler and superheater tubes.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 9S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 9MS	25-20
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 9	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

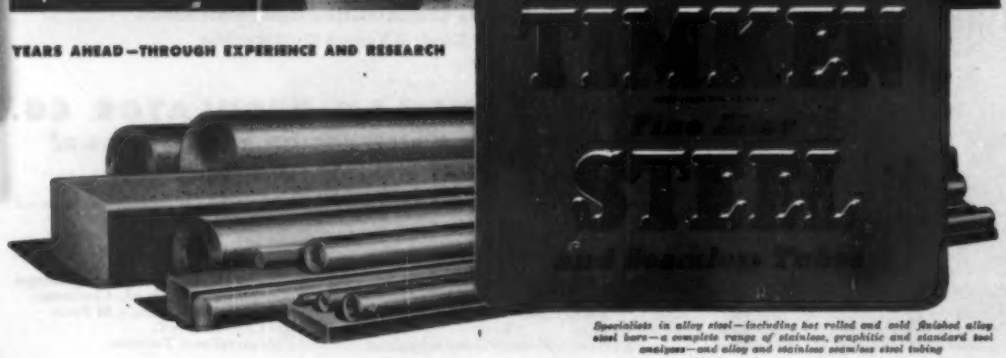
If your high temperature tubes either fail too soon or last longer than needed, they're costing you too much. Only *one* high temperature steel can give you the best life/cost ratio. It's the one that's tailor-made for your particular operating conditions.

To make sure you get the *right* steel, consult the recognized authorities in this field—the Timken Company metallurgists. Their recommendations are backed by 24 years of pioneering research and the widest field experience. They have 23 analyses to choose from. And uniform tube quality is assured by our complete control from melt shop through final inspection.

Let the Timken Company's "RSQ"—Research, Supply, Quality—solve *your* tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, O. Cable address: "TIMROSCO".

Photo shows metallographic laboratory at the Timken Company, where structural characteristics of high temperature steels are determined. The Timken Company was first to test high temperature steels, and still leads in that research today.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

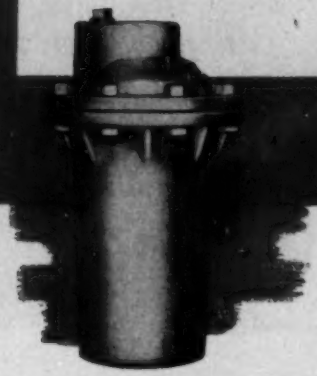


Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard steel analyses—and alloy and stainless seamless steel tubing

NO STEAM LOSS

FROM ZERO TO FULL LOAD

ARMSTRONG TRAPS DON'T PASS STEAM



UNLIKE some devices, Armstrong traps will not pass steam, regardless of load conditions. The diagrams at the right show this conclusively. Under no-load conditions here is what happens: steam in the bucket eventually condenses due to radiation loss. When enough condensate is formed in this manner to cause the bucket to lose buoyancy and sink, the trap empties itself and the cycle repeats. The radiation loss is small—as it would be in any device of similar size. There is no steam loss!

When there is a condensation load, the operation is the same except that the trap remains open until all condensate flowing into it is discharged.

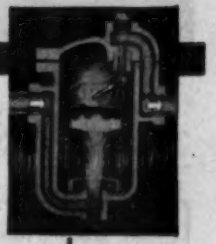
Freedom from steam loss saves fuel, keeps down back pressure in return lines. Call your nearby Armstrong Representative for the traps you need now.

ARMSTRONG MACHINE WORKS

852 Maple Street • Three Rivers, Michigan

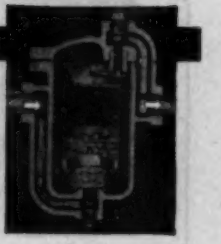
OPEN

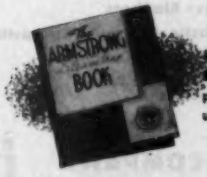
When accumulated water causes bucket to lose buoyancy, trap opens wide.



CLOSED

After condensate is discharged, steam entering bucket causes it to float, closing the valve tight. Valve remains closed until steam condenses.





SEND FOR THE 36-PAGE STEAM TRAP BOOK. It tells you how to do the best possible trapping job with facts, figures and diagrams.

ARMSTRONG STEAM TRAPS

He's the man who can show you the proper insulation to get maximum heat and power from each fuel dollar expended.

Here's one insulation that will save you money

EAGLE-PICHER SUPER "66" INSULATING CEMENT

Super "66" is all-purpose, rust-inhibitive, extremely adhesive insulating cement. "Springy ball" pellets don't collapse after application . . . give great coverage, retain their thermal efficiency. 100 lbs. covers 65 sq. ft.—1 inch thick! Easily applied with trowel, over flat and irregular surfaces. Efficient for temperatures up to 1800°F. Reclaimable when used on equipment whose temperatures do not exceed 1200°F.!

An Eagle-Picher Industrial Insulation distributor or representative can help you reduce operating expenses because he has available a wide line of insulation products—for high and low temperatures—scientifically designed for maximum thermal efficiency, and practical application. Why not let him give you more information about some of the products listed here?

These Eagle-Picher products can save you money . . . power . . . time

Insulating Felts • Supertemp Blocks • Blankets
Loose Wool • Pipe Covering • Stalastic • Insulseal • Insulstic
Swetchek • Finishing Cements • Insulating Cements
Fireproofing Cement • Diatomaceous Earth Blocks

THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

EAGLE EP PICHER

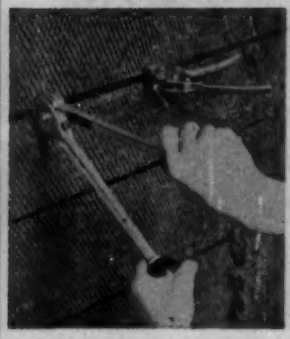
Since 1843

Get maximum fuel savings and exact temperature control with these versatile, efficient insulations

For a completely effective, low-cost insulation combination, you can't beat the teamwork of Eagle-Picher Mineral Wool Blankets, Supertemp Blocks, Super "66" Insulating Cement, No. 106 Fireproofing Cement and Insulseal. They work effectively to give your equipment highest possible thermal efficiency . . . cut operating costs by saving maximum amount of fuel . . . and help to provide perfect, precise control over temperatures.

EAGLE-PICHER FIREPROOFING CEMENT

Mixed with water to form a stiff plastic mix for easy application on ribbed lath. Recommended for fireproofing structural steel columns, steel tank supports, skirts and equipment bases. Has high dry coverage of approximately 30 sq. ft. 1 inch thick per 100 pounds. Adds fire protection, patented rust-inhibitor resists corrosion. Tested by Underwriters' Laboratories, Inc.



EAGLE-PICHER MINERAL WOOL BLANKETS

These blankets satisfy the need for a convenient method of quickly and efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured between flexible metal fabric. Outstanding physical and chemical stability enables Eagle-Picher Blankets to resist water, steam, corrosive fumes and normal vibration.

EAGLE-PICHER SUPERTEMP BLOCKS

Eagle-Picher Supertemp Blocks are lightweight (approximately 16 lbs. per cu. ft.). Can be cut easily with knife or saw to fit off-shaped areas . . . they fit snugly over minor irregularities. They're strong and have high refractory value. Withstand temperatures up to 1700° F. Conductivity at 512° F. approximately 0.43 . . . all standard sizes, from 3" x 18" to 12" x 36" . . . in thicknesses from 1" to 4".

EAGLE-PICHER INSULSEAL

A tough, weatherproof, protective coating for insulation. For temperatures up to 450° F. Applied as a plastic, its smooth troweling qualities assure uniform coverage, proper thickness. It protects insulation from air infiltration, fumes, rain, snow, vibration, punctures, and withstands severe service, indoors or out. Dries to a smooth, rich black, has a neat appearance on hot or cold surfaces . . . may be washed or painted.

THE EAGLE-PICHER COMPANY General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

EAGLE EP PICHER *Since 1843*

WHY RISK THIS TO SAVE A DIME A WEEK?

Expensive re-running in many a plant—whether it makes gasoline, drugs or heavy chemicals—thrives on poor temperature control. And the margin is often narrow . . . a variation of only a few degrees meaning thousands of dollars in slop material or damaged equipment.

Yet many plants risk this loss without realizing it! They attack the temperature control problem correctly, by using potentiometer pyrometers to get top accuracy and dependability. But they sometimes slip on the "standardizing" adjustments which such instruments need to maintain those qualities. Overlooking the need for frequent and regular standardizing, these plants permit the operation to be done by hand . . . and thus possibly skimped or forgotten.

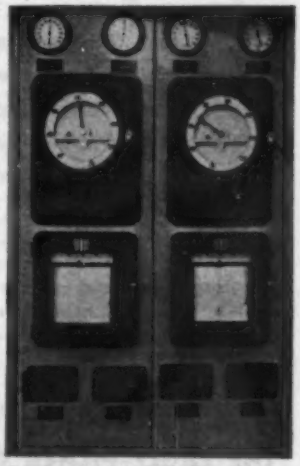
There is just one way of removing this threat to the accuracy of process temperature. It's by putting the standardizing responsibility where it belongs . . . directly on the recorders and controllers themselves.

A relatively simple device, the automatic standardizer, should be built into the potentiometer to handle this job. It checks the measuring circuit at least every 48 minutes . . . adjusts when necessary without upsetting the process . . . *never forgets!* And this essential feature, amortized in the usual 10 years, costs less than 10¢ a week!

So, regardless of what make instruments you buy, be sure to specify automatic standardizing. It's cheap . . . safe . . . sure!

Write Leeds & Northrup Company, 4923 Stenton Ave., Phila. 44, Pa.

AUTOMATIC STANDARDIZING
Guards Product Quality When You Use Instruments Like These



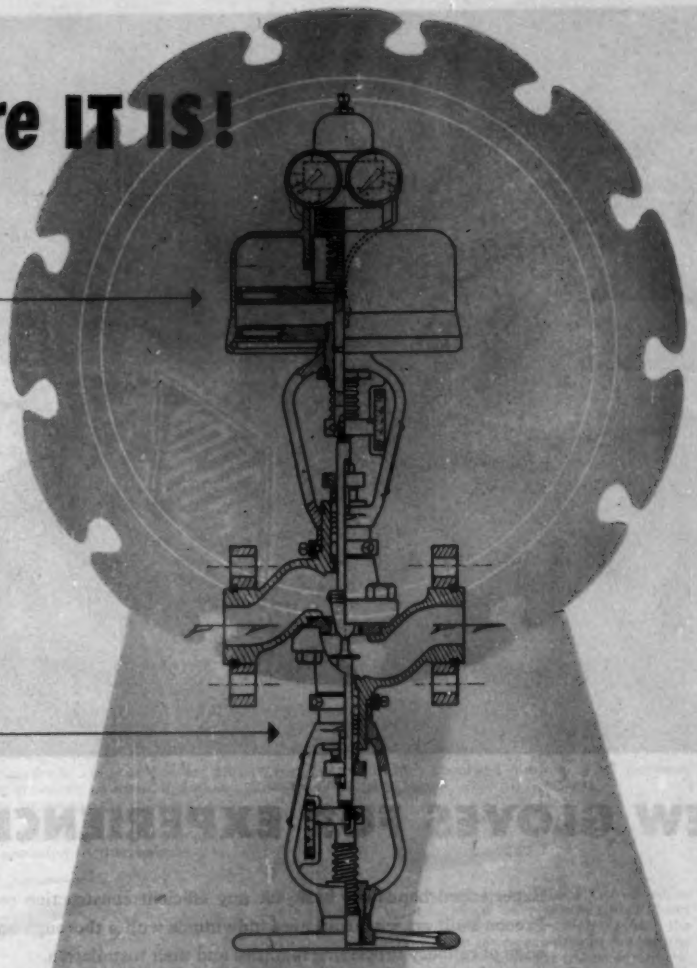
Four out of the 17 Speedomax Controllers which help maintain production of one process unit in an Eastern chemical plant.

Jrl Ad ND4(3a)

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Here IT IS!



AUTOMATIC

DOMOTOR—For Automatic Control—Sealed piston in dome, actuated by internally controlled differential pressures, insures powerful stable valve action. Built-in null type positioner unit. Light weight, economical and flexible with proven dependability.

MANUAL

HANDWHEEL—For Manual Control—Perfect for those start-up periods or for operation during instrument repair. Provides positive manual control when desired or may be used as an adjustable limit stop. Incorporates advantages of continually connected control valve without the usual mechanical complications.

The Combination Valve you asked for

Now for the first time you get all the advantages of the powerful Domotor Valve plus the versatility of the Handwheel Valve combined in one valve. The single seated, split construction body that has already brought many advantages to valve buyers in the way of versatility, ease of maintenance and smooth flow has now made possible this newest achievement. The operational flexibility of this combination valve is unlimited—inventories are reduced—no changeover time—and as with all Annin valves, precise control of hard-to-handle fluids is assured. Write today for complete information.

REMEMBER—Teflon Chevron packing has been standard equipment on all Annin Valves for over two years.

ANNIN CONTROL VALVES

THE ANNIN COMPANY
3500 Union Pacific Avenue, Los Angeles 23, California

NEW GLOVES FOR EXPERIENCED HANDS

Experienced hands are basic for any efficient construction service. That is why Procon built an organization of individuals with a thorough and complete knowledge of refinery processing facilities and their installation.

From top to bottom... in all important posts at Procon, you will find men who have spent years in this type of work... men who worked together under a single banner and who are thoroughly schooled in all phases of refinery process operations.

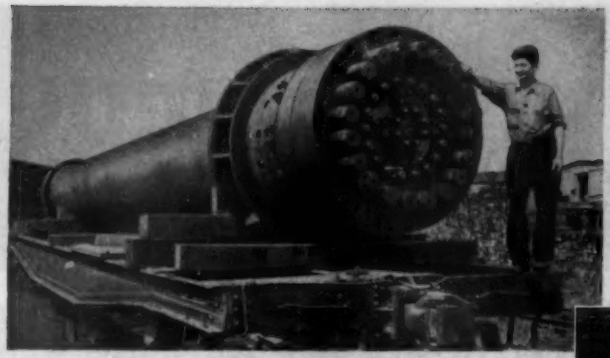
So, these experienced hands in new gloves offer the industry an opportunity to acquire a construction service that reaches beyond the usual concepts. A service that affords the ultimate in efficiency and invested-dollar value.

If your plans call for refinery construction work, we will be glad to discuss requirements in view of giving you the benefits provided through Procon service.

PROCON *Incorporated*

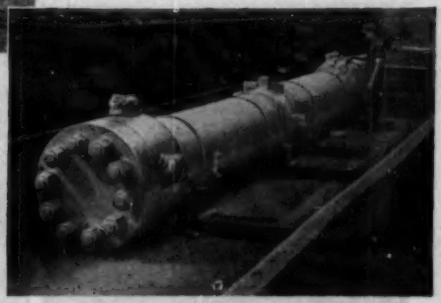
PROCESS CONSTRUCTION

75 EAST JACKSON BLVD., CHICAGO 4, ILLINOIS



One of several MULTI-LAYER Converters designed for 5000 psi working pressure, with corrosion-resistant type 405 alloy inner shell. Wall thickness 8¼ inches, weight 182,000 lb. This type of construction is ideal for high pressure synthesis of coal and shale.

MULTI-LAYER Heat Exchanger designed for 5100 psi working pressure. Wall thickness 4⅝ inches, weight 45,800 pounds.



A.O.Smith
MULTI-LAYER
Heat Exchangers & Pressure Vessels

The practical, *economical* solution to your high pressure process and storage requirements

MULTI-LAYER vessels are built-up from concentric layers of relatively thin steel plate, progressively *wrapped, tightened* and *welded* around an inner, pressure-tight cylinder.

Greater range of process possibilities for the planning and design engineer are provided in this unique, patented construction.

Walls can be made stronger merely by increasing strength of steel wrapping plates or by adding more layers.

For corrosive service, only the inner cylinder need be fabricated of alloy or non-ferrous materials.

No size or weight limitations as MULTI-LAYER vessels or heat exchangers can be made in any diameter for which satisfactory end closures are available.

The full calculated strength of the steel is more fully utilized in MULTI-LAYER vessels. Wrapping tension and weld shrinkage develop compression in the inner layers. This results in more equalized loading of all portions of the vessel wall under working pressure.

Safety is greatly improved by MULTI-LAYER construction. Only the inner cylinder need be pressure tight! Outer layers are provided with vent holes which protect the vessel against damage from over-pressure. In the remote event of run-away overload sufficient to cause failure, there is little danger of fragmentation of the vessel wall, due to the nature of MULTI-LAYER construction.

Consult A. O. Smith for assistance on your heat-exchanger or pressure-vessel problems. In any event, write for Bulletins V-52 and V-53 for more complete information on MULTI-LAYER Pressure Vessels and their construction . . . or use handy coupon.

A.O.Smith 77th ANNIVERSARY 1874 · 1951

A.O.Smith

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Dept. PR-451, Milwaukee 1, Wis.

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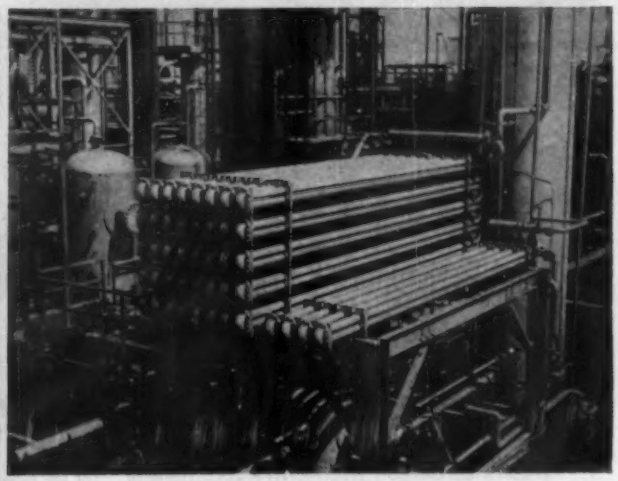
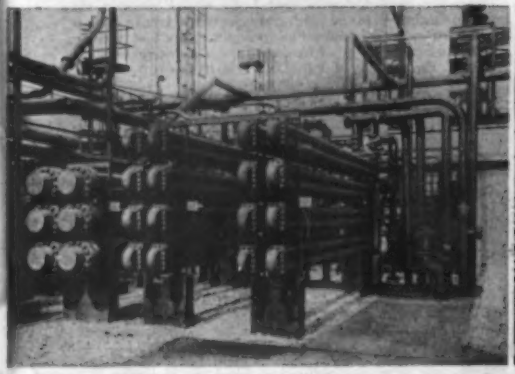
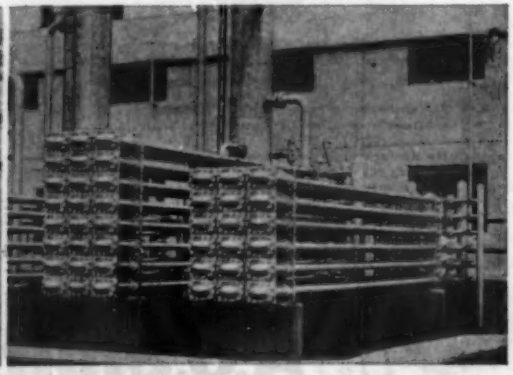


Notice the flexibility in installed arrangement of G-R Twin G-Fin Sections as shown by the illustrations. Many concerns are using several hundreds of Twin G-Fin Sections on heat transfer duties all over the plant because of their unequalled adaptability to a wide range of service requirements.





GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

you can take "off the shelf"

Have you ever thought how convenient it would be to be able to "stock" heat exchangers . . . just as you do with valves, fittings and bolts . . . so as to have them ready as quickly as you need them for heat transfer services?

You can do it with the G-R Twin G-Fin Section . . . the multi-purpose heat exchanger. These units can be set up in stacks just like a sectional book-case. They can be grouped in parallel or series for complete flexibility of capacity and temperature range. You can use them for practically any condensing, cooling, heating or heat exchange service. They are easily and quickly transported and piped up.

When you need a new heat exchanger, just write, phone or wire us to ask the Twin G-Fin Section set-up that will do the job. If the service conditions of an existing Twin G-Fin Section installation are changed, it's a simple matter to add or remove one or more sections. And if an existing installation is no longer needed because of process changes, the units can be disconnected and returned to the storeroom for "stock", to be held until the next call for heat exchangers.

Many plants are already doing this. These plants need not wait for specially designed and manufactured heat exchangers for most of their services, nor do they have to pay the cost of "tailor made" units.

Just think of the advantages for your own plant . . . and write us for full information.

ADVANTAGES OF THE

G-R TWIN G-FIN SECTION

1. SIMPLE . . . just the patented G-Fin pipe within a shell. The patented stationary head closure has only 3 parts.

2. EFFECTIVE . . . the famous longitudinal G-Fins have 6 to 11 times as much external heat transfer surface as bare tubes, requiring less surface for a given duty.

3. STURDY . . . designed for pressures up to 1800 psig. The heat transfer elements are pipes of standard thickness, not thin gauge tubes.

4. DURABLE . . . proven by the operating results of more than 50,000 installed units, some of which have been in service for as long as 15 years.

5. CONVENIENT . . . easily transported . . . easily installed . . . easily maintained.

6. ADAPTABLE . . . G-Fin elements and fins can be made of any ferrous or non-ferrous alloy regularly used in heat exchanger service.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

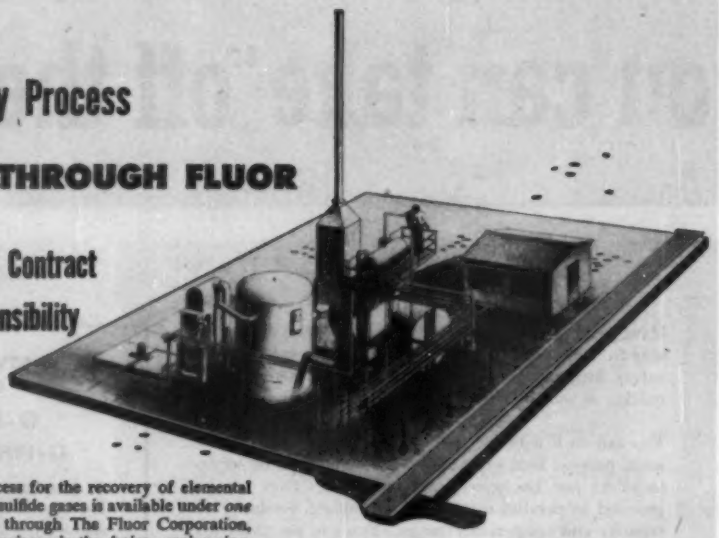
GRISCOM-RUSSELL

GO-525

The Mathieson Sulfur Recovery Process

AVAILABLE THROUGH FLUOR

- Under ONE Contract
- ONE Responsibility

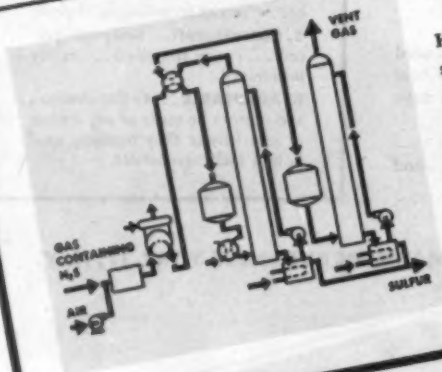


The proven Mathieson Process for the recovery of elemental sulfur from waste hydrogen sulfide gases is available under *one* contract, *one* responsibility through The Fluor Corporation, Ltd. With over 30 years' experience in the design, engineering, and construction of plants and facilities for the petroleum and chemical industries, Fluor possesses the background, the skilled personnel, and the know-how essential for the practical interpretation of the Mathieson Process into *your particular* sulfur recovery program.

Fluor is in a position to make economic studies covering every phase of proposed sulfur recovery installations—initial investment, operating costs, and returns to the investor.

A Simple Process for the Conversion of Waste Hydrogen Sulfide to Pure Elemental Sulfur

Hydrogen sulfide, recovered from a sour gas stream, is partially burned with air—cooling follows with steam generated being utilized for power. Combustion gases are then passed through a catalyst tower to form sulfur and water vapor. Elemental sulfur product is condensed in a wash tower by direct contact with cooled liquid sulfur. The result is pure commercial sulfur—ready for sale or for conversion into sulfuric acid.



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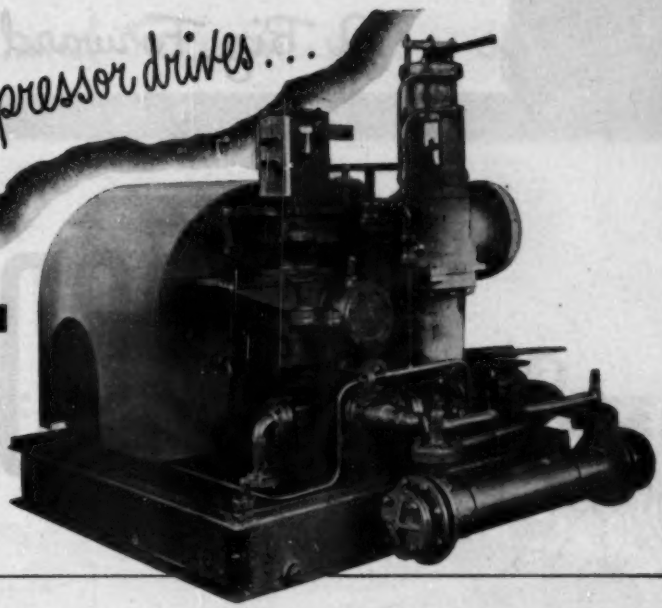
THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif.

New York, Chicago, Boston, Pittsburgh, Tulsa, Houston, San Francisco, Birmingham, Calgary.

REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

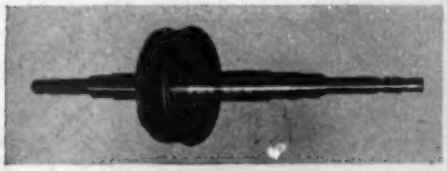
For your centrifugal compressor drives . . .

WORTHINGTON HIGH SPEED TURBINES!



Developing Up To 12,000 RPM, Worthington Turbines Are Outstanding For Driving Modern High Speed Centrifugal Compressors

Meeting the demand for steam turbine drivers for high speed machines, Worthington has developed a line of high speed turbines, many of which are already in operation. Smooth, steady driving power for blowers and centrifugal compressors is assured by a powerful oil relay governor — usually arranged for variable speed, either manually or through an outside controller.



Typical of the rugged construction of these turbines, the rotor illustrated is a single solid forging, with wheels and shaft integral. This rotor develops 3860 hp at 9150 rpm when supplied with steam at 600# G, 750° Ftt and 185# G exhaust.

For Your Motor Driven Centrifugal Compressors

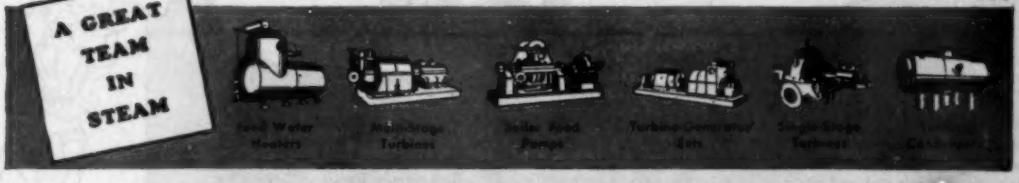
Worthington precision cut, high speed step-up gears increase motor speed to compressor speed. Gear teeth contours are carefully selected and machined for quiet operation and long life, while latest design high speed bearings reduce wear and assure trouble-free performance.

Get the facts on how these money-saving, always dependable turbines and gears prove *there's more worth in Worthington*. Write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.*

WORTHINGTON

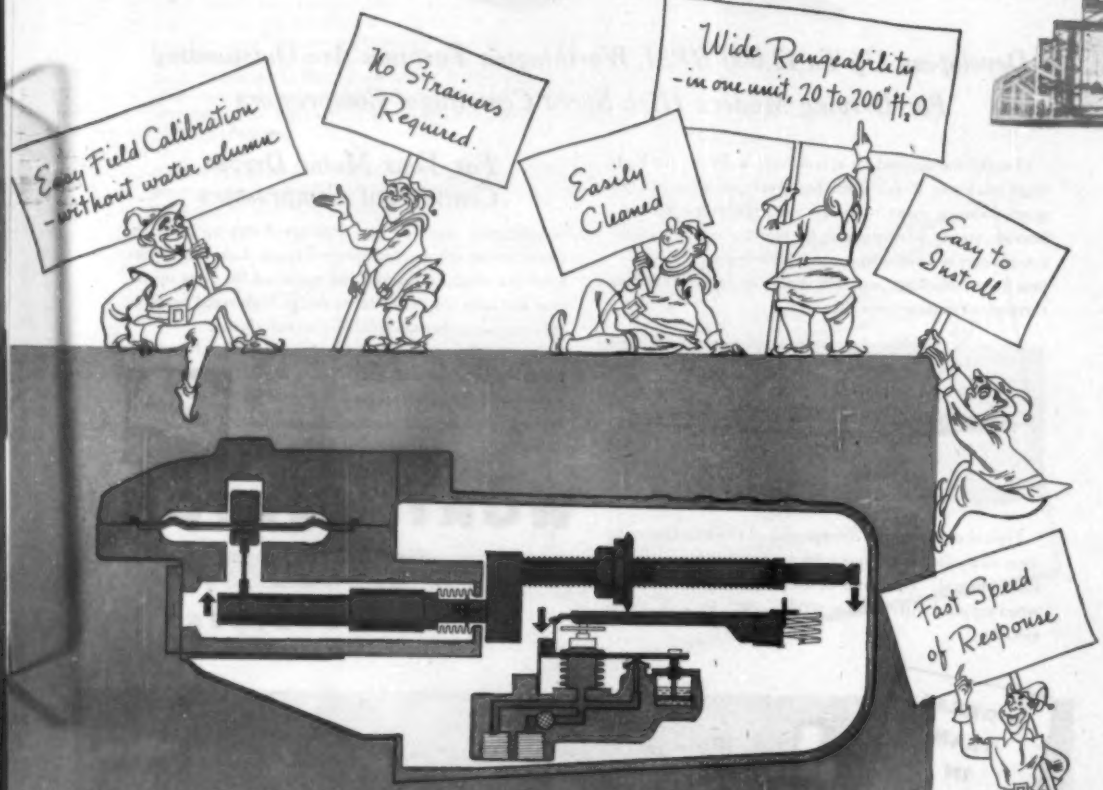
STEAM TURBINES

T0.4



A Big Forward Step In The

...INTRODUCING


Easy Field Calibration - without water column
No Strainers Required
Wide Rangeability - in one unit, 20 to 200" H2O
Easily Cleaned
Easy to Install
Fast Speed of Response

FUNCTIONAL SCHEMATIC CROSS-SECTION . . . Diaphragm, at upper left, separates low and high pressure chambers and is connected to primary beam. Movement of diaphragm acts upon secondary beam through contact of rider (range change adjustment). Secondary beam moves flapper toward nozzle, causing pressure to build up in balancing bellows . . . thereby creating upward force to balance differential pressure. This entire sequence of actions is practically instantaneous.

Measurement and Transmission of Flow

AFTER long and rigorous testing in the field, the Brown Differential Converter is ready to set new high standards of simplicity and precision in the measurement and transmission of flow.

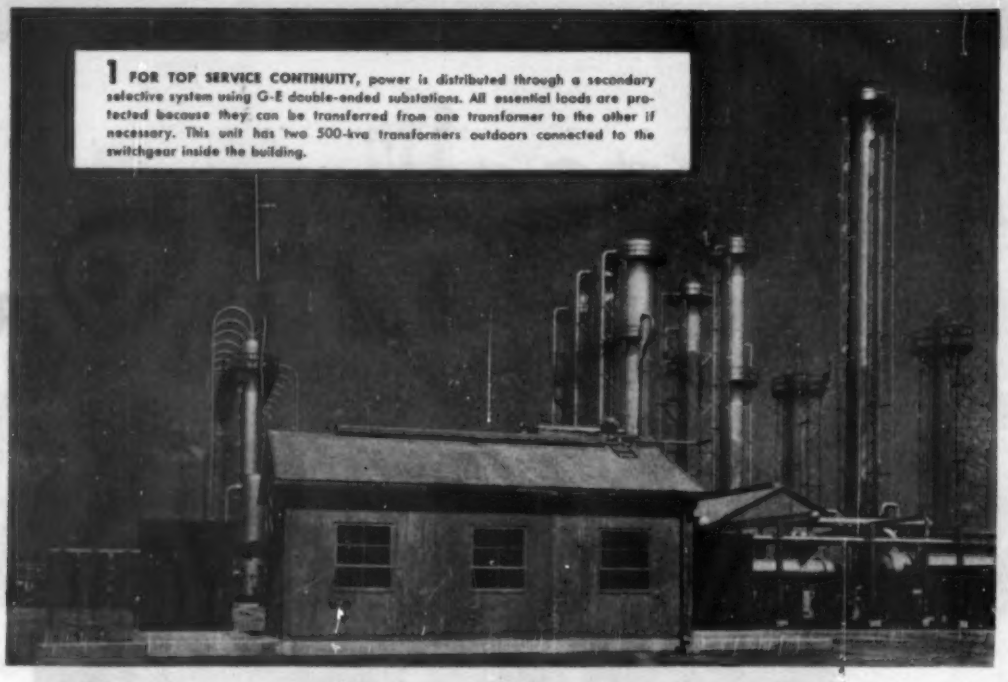
Operating on the pneumatic-balance principle, this compact and light-weight unit converts differential pressure at the orifice into a proportionate output air pressure which is a measure of flow. All adjustments . . . such as the range change which is continuous from 0-20 inches of water up to 0-200 inches of water . . . are easily and simply made, without special tools or extra parts.

Applicable to a wide range of continuous processes, the Brown Differential Converter is the fore-runner of an entirely new series of pace-setting developments made possible through Brown *Creative Instrumentation*. For detailed information write for a copy of new Catalog No. 2281 . . . and call in our local engineering representative for a discussion of your process needs. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

A PHOTO-REPORT ON MODERN



1 FOR TOP SERVICE CONTINUITY, power is distributed through a secondary selective system using G-E double-ended substations. All essential loads are protected because they can be transferred from one transformer to the other if necessary. This unit has two 500-kva transformers outdoors connected to the switchgear inside the building.

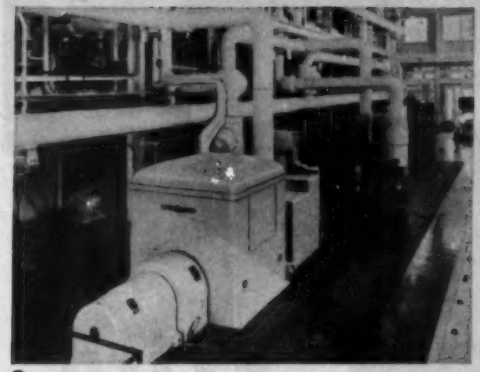
Gas cycling plant protects its ½-billion-CFD capacity!

Uses General Electric equipment—including double-ended unit substations in secondary selective arrangement—to maintain high service continuity

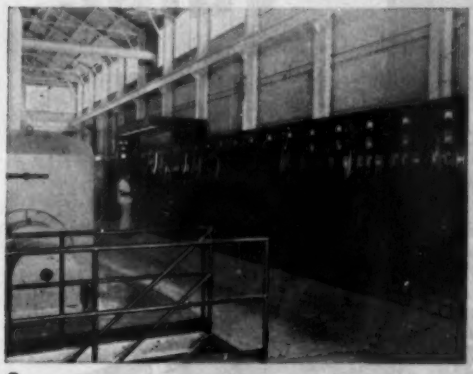
Stripping condensible by-products from "wet" gas, compressing it as "dry" natural gas, and injecting it back into the production formation, calls for power-system reliability—especially when it's done at a rate of 500 million cubic feet per day! To help safeguard production continuity in key areas at this large Gulf Coast cycling plant near Katy, Texas, reliable General Electric equipment is used. It will pay you to look to General Electric for all *your* refinery's electric equipment, plus skilled engineers to help apply it most economically. Ask your local G-E representative for the full story —soon. *Apparatus Dept., General Electric Company, Schenectady 5, N.Y.*

GENERAL ELECTRIC

661-25

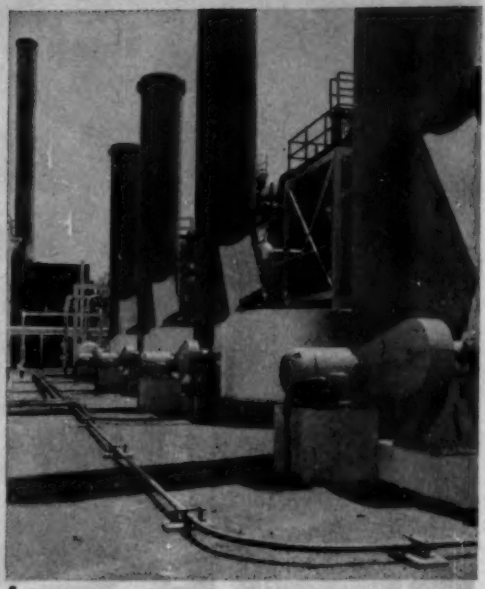


2 **DEPENDABLE POWER GENERATION** is provided by these two G-E turbine-generator sets, each rated 2500 kw, 4160 volts, with top-mounted generator coolers. The 6-stage turbines are rated 600 psig, 700 degrees F, 265 psig back pressure. G-E turbine-generators, designed for reliable operation, give maximum output per dollar of fuel cost.

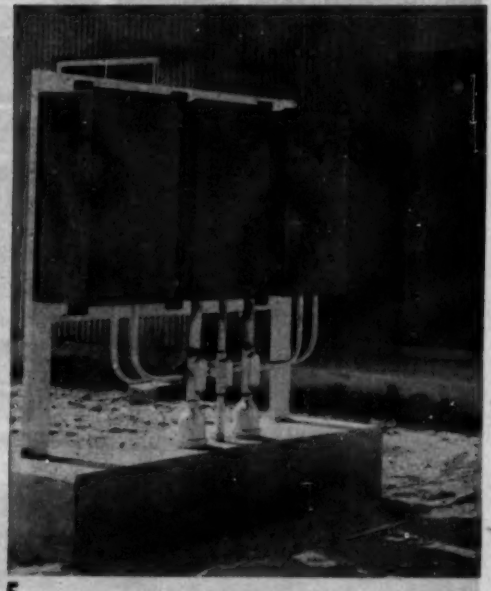


3 **COMPLETE CONTROL** of plant-generated power is supplied by this G-E 4160-volt metal-clad switchgear. Deadfront metal enclosures protect operating personnel. Circuit breakers—of adequate interrupting capacity for the plant's needs—are easily removable to simplify maintenance. Units are shipped assembled, ready for easy installation.

*Reg. Trade-mark of General Electric Co.

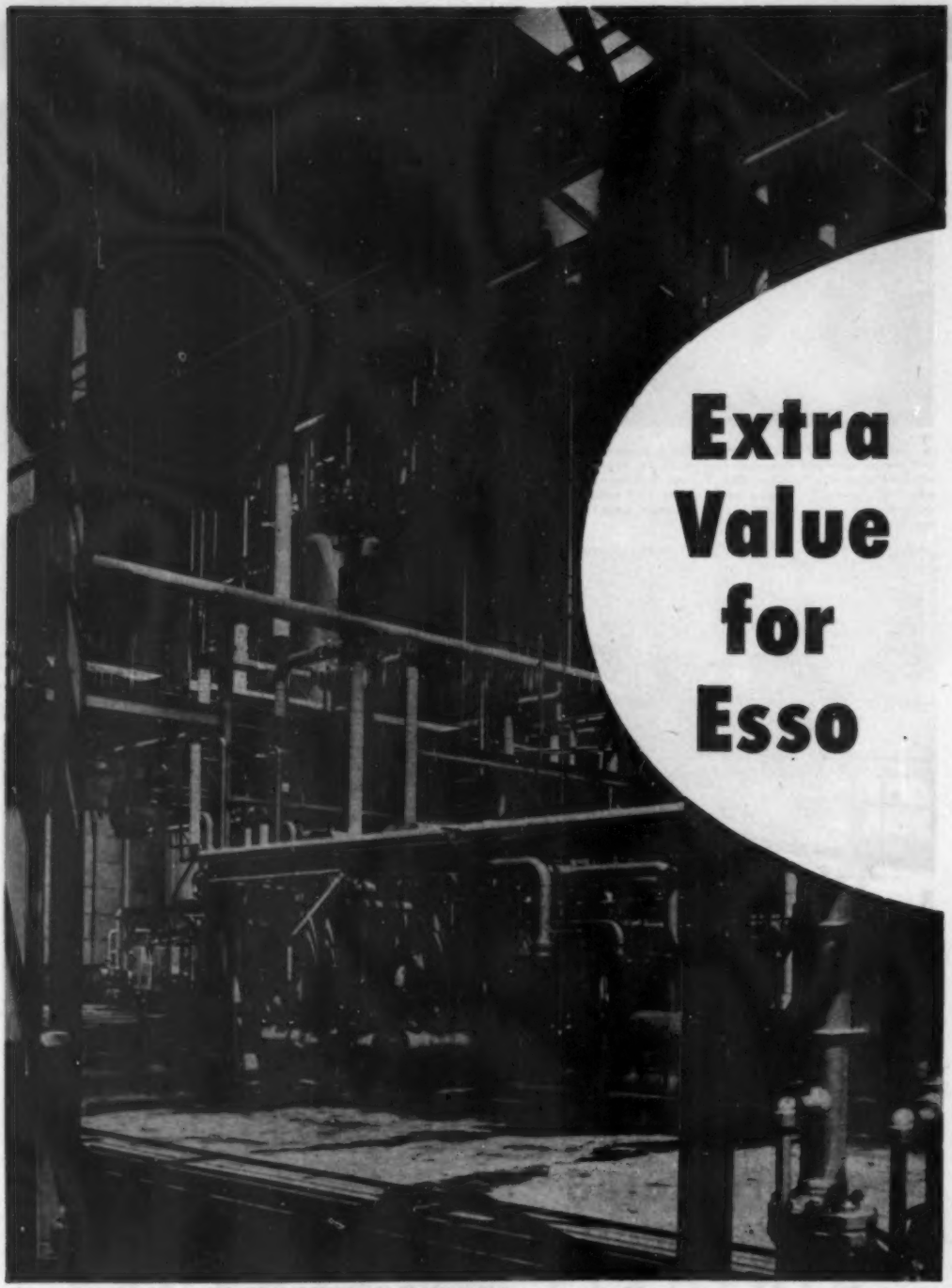


4 **3-WAY EXTRA PROTECTION** against physical damage, electrical breakdown, and operating wear and tear is built into these four G-E, Tri-Clad* totally enclosed fan-cooled motors driving outdoor boiler fans in the Katy plant. Rated 75 hp, 440 volts, 1200 rpm, they have corrosion-resistant cast-iron enclosures to withstand acids, alkalis and solvents.



5 **TO PREVENT CORROSION** of piping, G-E rectifiers are used for cathodic protection. Giving longer life, lower maintenance costs, and reduced shutdown time, G-E selenium rectifiers incorporate corrosion-resistant, oil-immersed stacks which are hermetically sealed against contamination by moisture or fumes in the air.

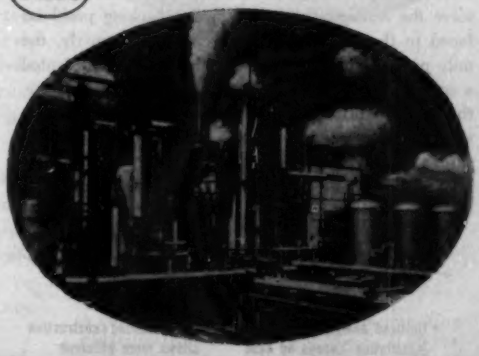
Co-ordinated ELECTRIC EQUIPMENT for Gas Cycling and Repressuring



MEK Dewaxing Unit with charge capacity up to 7500 BPD, designed, engineered and constructed by Badger for Esso Standard Oil Company at Bayonne, N. J. Process licensed by Texaco Development Corporation.

This MEK Dewaxing Unit, recently completed at Bayonne, N. J., for Esso Standard Oil Company, is the largest and newest of three such units which Badger has recently designed and constructed for Esso and an affiliated company. Improvements and modifications in each successive unit have provided extra values for Esso, in lower initial cost, earlier completion, more economic operation and easier maintenance.

Badger's broad experience in the design and construction of every type of petroleum and chemical unit means extra value for all Badger clients.



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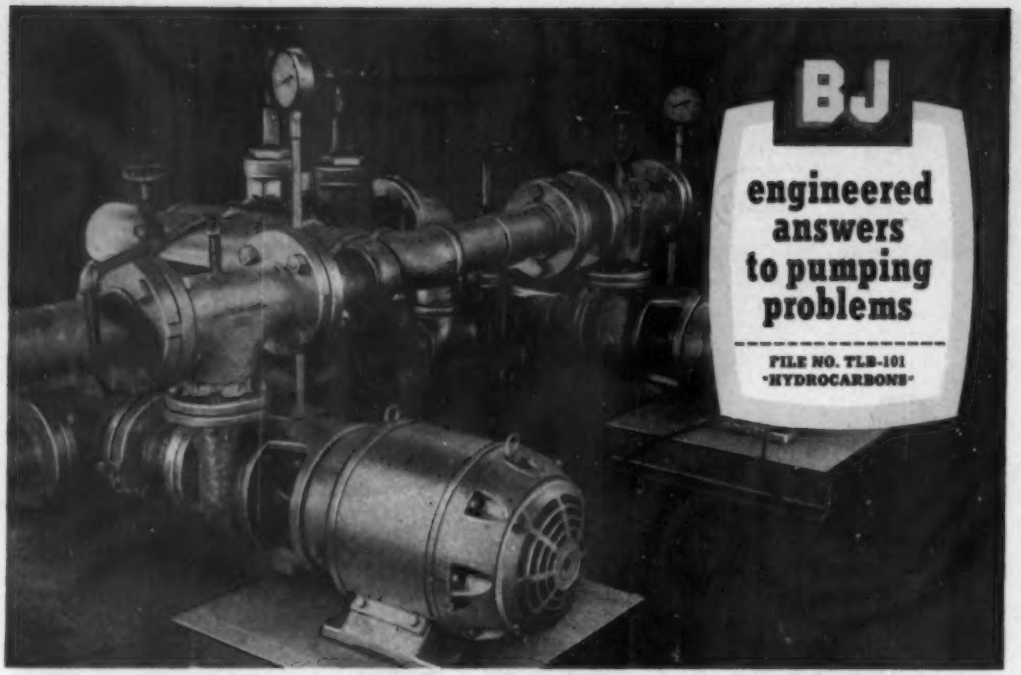
Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries



General Petroleum reports:

Mechanically-sealed BJ Type TLB Pumps handle hydrocarbons without leakage, fire hazard, repacking problems or special operating attention

Byron Jackson engineers developed the TLB pump to solve the leakage, fire hazard and repacking problems faced in the handling of hydrocarbons. Formerly, the only pumps which met these requirements represented a considerable investment in cost and installation. Now, the BJ Type TLB offers a sensibly-priced unit, easily installed and operated with a minimum of attention. It features a simple, efficient BJ Mechanical Seal which replaces the packing in the stuffingbox and provides a reliable safeguard against leakage.

The installation shown above is at General Petroleum's Bakersfield Bulk Plant. Two BJ Type TLB Pumps are used here for loading gasoline and diesel fuels, pumping 160 gpm against 62 ft. total head. Explosion-proof 3 hp, 3-phase, 60 cycle, 220/440 v motors operate at 3550 rpm.

For the engineered answer to *your* standard or special pumping needs contact your local BJ sales office or write direct. For more information on these TLB Pumps —including pump selection table and friction compensation charts—send the coupon below.

FILE FACTS:

- Unitized design simplifies installation—needs no base plate—saves space—mounts at any angle.
- No packing to maintain.
- BJ Mechanical Seal cooled by pumped liquid.
- Single-stage, single-suction pump sizes from 1½" to 4".
- Close-coupled construction allows more efficient application of power to pump.
- Capacities to 1000 gpm. Heads to 200 ft.
- Discharge pressure: 75 psi.
- Max. working temperatures: 150°F.
- Explosion-proof motors.

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Please send me your TLB Bulletin No. 50-9200

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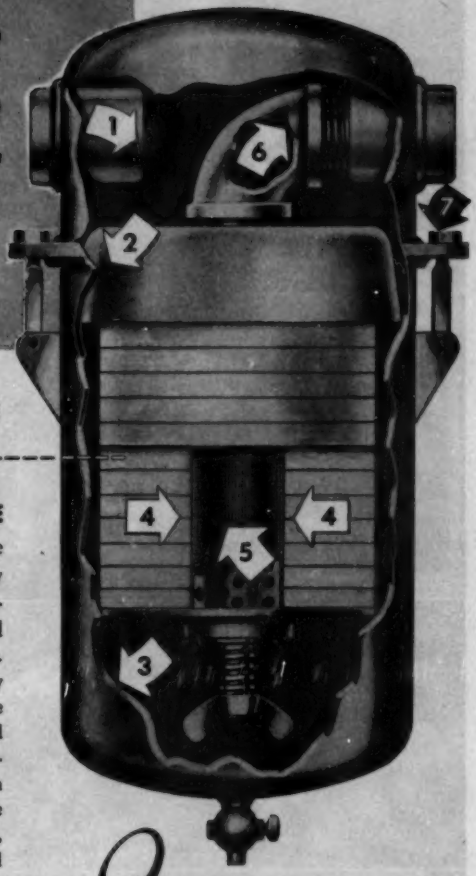
Removes Last Traces of Oil and Moisture from *INSTRUMENT AIR LINES....*



THICK FELT DISCS PROVIDE SUPER FILTRATION

DOUBLE ACTION PRINCIPLE REMOVES MOISTURE AND DIRT TWO WAYS—Here's the greatest pipe line filter ever developed for removal of every trace of foreign matter, condensed oil and moisture from instrument control lines. Air is cleaned by both *mechanical separation* and *filtration/absorption.* Air entering filter Inlet (1) strikes Deflector Cup (2) by which heavier droplets of water and dirt particles are directed to sides of Housing (3) and thence downward at high velocity to base where liquid and heavier particles are deposited. The *mechanically cleaned* air then passes at low velocity thru the Discs (4) which *filter* the air and *absorb* the last traces of oil and moisture. Clean, dry air passes out thru fine mesh Bronze Screen (5) and Outlet (6). Swing Bolts (7) on head for easy inspection are optional.

While originally designed for the protection of pneumatically operated control apparatus, these revolutionary filters are now used as a primary or final stage of filtration for an ever-increasing number of tools, devices and processes. Many highly successful installations are reported in which no other filter had proven satisfactory.

Request Bulletin B-1A, mentioning problem involved for specific engineering information. Please direct your inquiry to Dept. 47.

Staynew

ABSORPTION FILTER

A complete range of sizes available, handling capacities from 5 to 100 CFM free air at 80 lbs. gauge pressure in standard pipe sizes from ¼" to 2". Model illustrated is AAPHS (swing-bolt head). Available also is Model AAPH, identical except for bolted-head construction.

DOLLINGER MFG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

DOLLINGER CORPORATION

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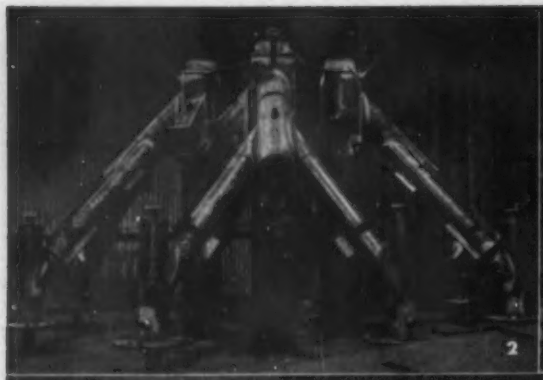

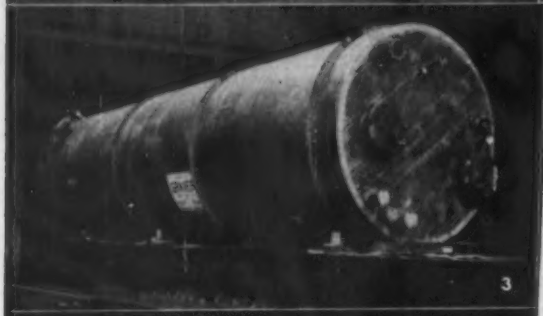

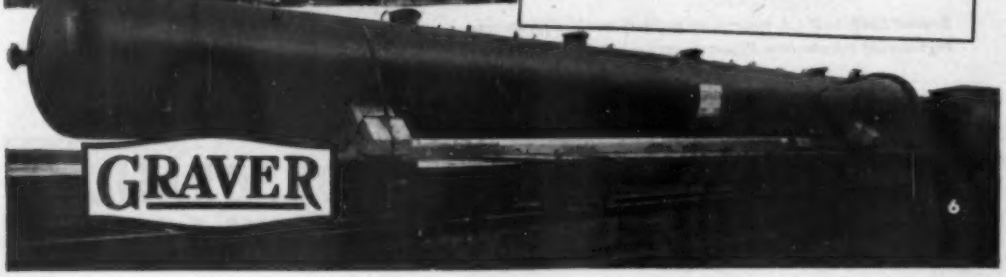

RECENT REFINERY VESSELS FROM GRAVER SHOPS

These pictures show the significant part Graver is taking in the modernization and expansion of the nation's refinery facilities.

1. Two sections of a Separator Surge Tank, 14′0″ x 35′2″
2. Part of a Catalyst Airlift
3. Fines and Fresh Catalyst Storage Bin, 12′0″ x 48′3″
4. Houdry Process Vessel of molybdenum steel, 12′0″ x 50′0″
5. Desalting Tank, 12′0″ x 40′0″
6. Refinery Tower, 7′0″ x 102′11″

These fabrications are exhibits of Graver versatility and indicate the extent of Graver Services to the petroleum industry.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

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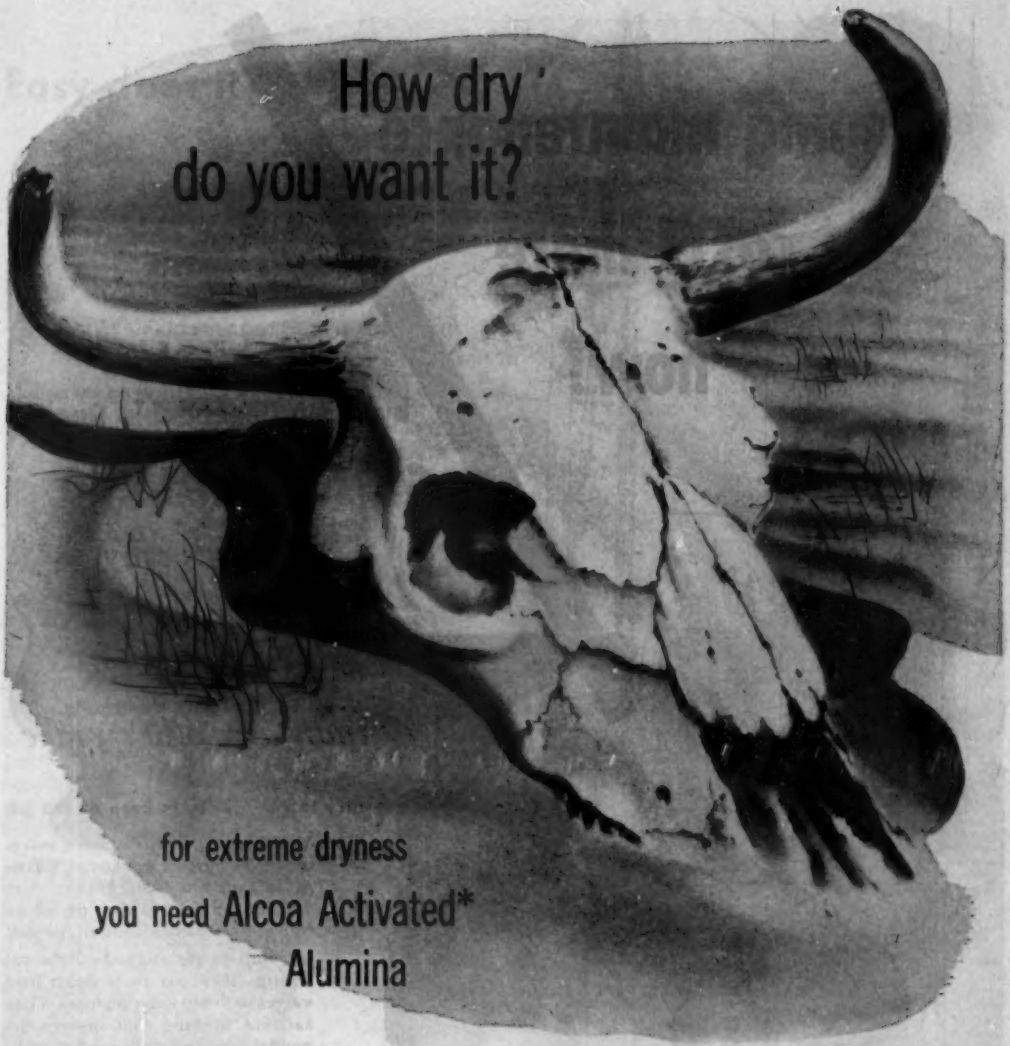

Every day more and more petroleum companies are discovering the efficiency and economy of ALCOA *Activated* Alumina for the dehydration of liquids, vapors and gases. They know that it's one of the most effective desiccants they can buy. Dew points as low as *minus 100° F.*—and even lower—can be obtained, and ALCOA *Activated* Alumina can be used for an almost indefinite number of drying cycles.

ALCOA *Activated* Alumina has high resistance to crushing, shock and abrasion . . . will not soften, swell or disintegrate even when immersed in water . . . is non-toxic . . . non-corrosive . . . high in purity . . . practically iron-free.

ALCOA *Activated* Alumina is used to adsorb certain gases and vapors from gaseous mixtures, and serves as a catalyst and catalyst carrier.

What do you dry? How dry do you want it? Whatever your answer, it will pay you to investigate ALCOA *Activated* Alumina. We will gladly send you complete information. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 617D Gulf Building, Pittsburgh 19, Pennsylvania.

FREE—A color print of this illustration on heavy 12" x 18" stock, without advertising matter, suitable for framing. Write us.

** Reg. T.M., Aluminum Co. of America*

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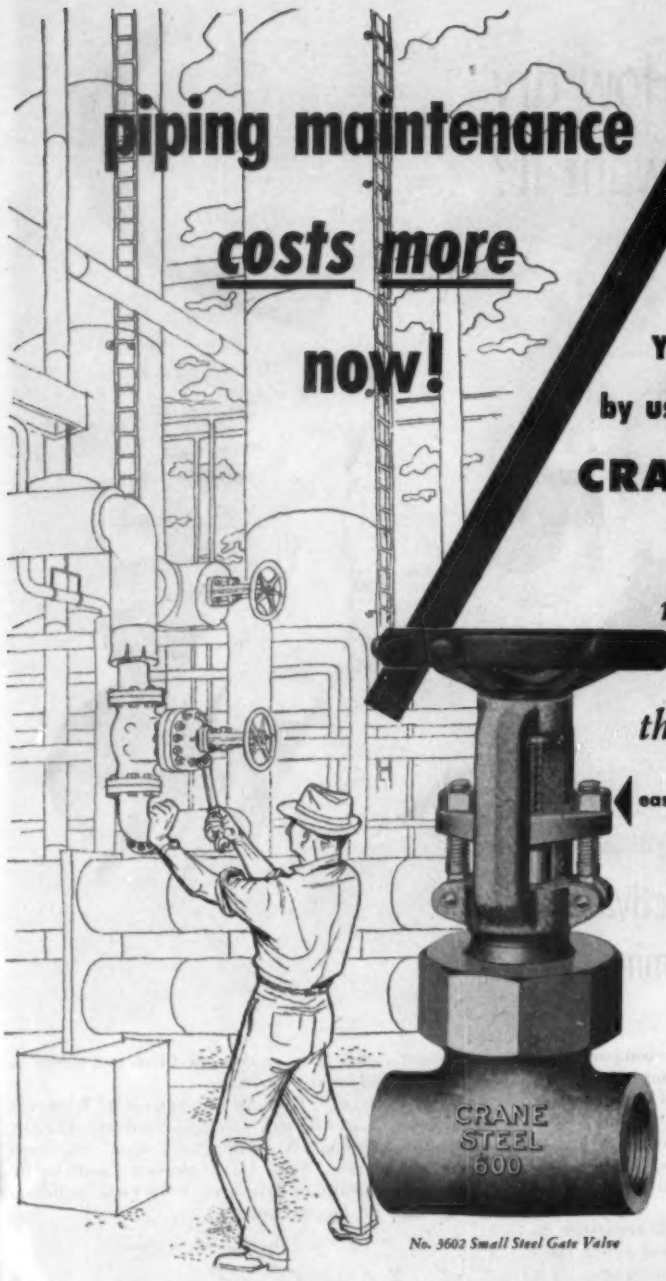
piping maintenance costs more now!



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You do less of it by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

easy to use...easy to keep on the job

You'll have much less valve maintenance wherever you install Crane 600-Pound Small Steel Gates. Use with recommended trim on oil or oil vapor, steam, water, air, or gas.

Compact yet rugged—light yet strong—these are truly small steel valves with big valve features. They sacrifice nothing that insures dependability and tight seating, easy operation, and convenience in keeping them in top-notch working condition.

Supplied in sizes 2 inches and smaller, No. 3602 valves are engineered to the standards that make Crane Quality your best choice in valves of every type.

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Rolling-in ELECTRUNITE Stainless Steel Pressure Tubes at Struthers Wells Corporation, Warren, Pa.

● Always uniform in size . . . always uniformly ductile . . . ELECTRUNITE Stainless Steel Heat Exchanger and Condenser Tubes always roll in smoothly and easily. For complete information about these modern pressure tubes, write to:

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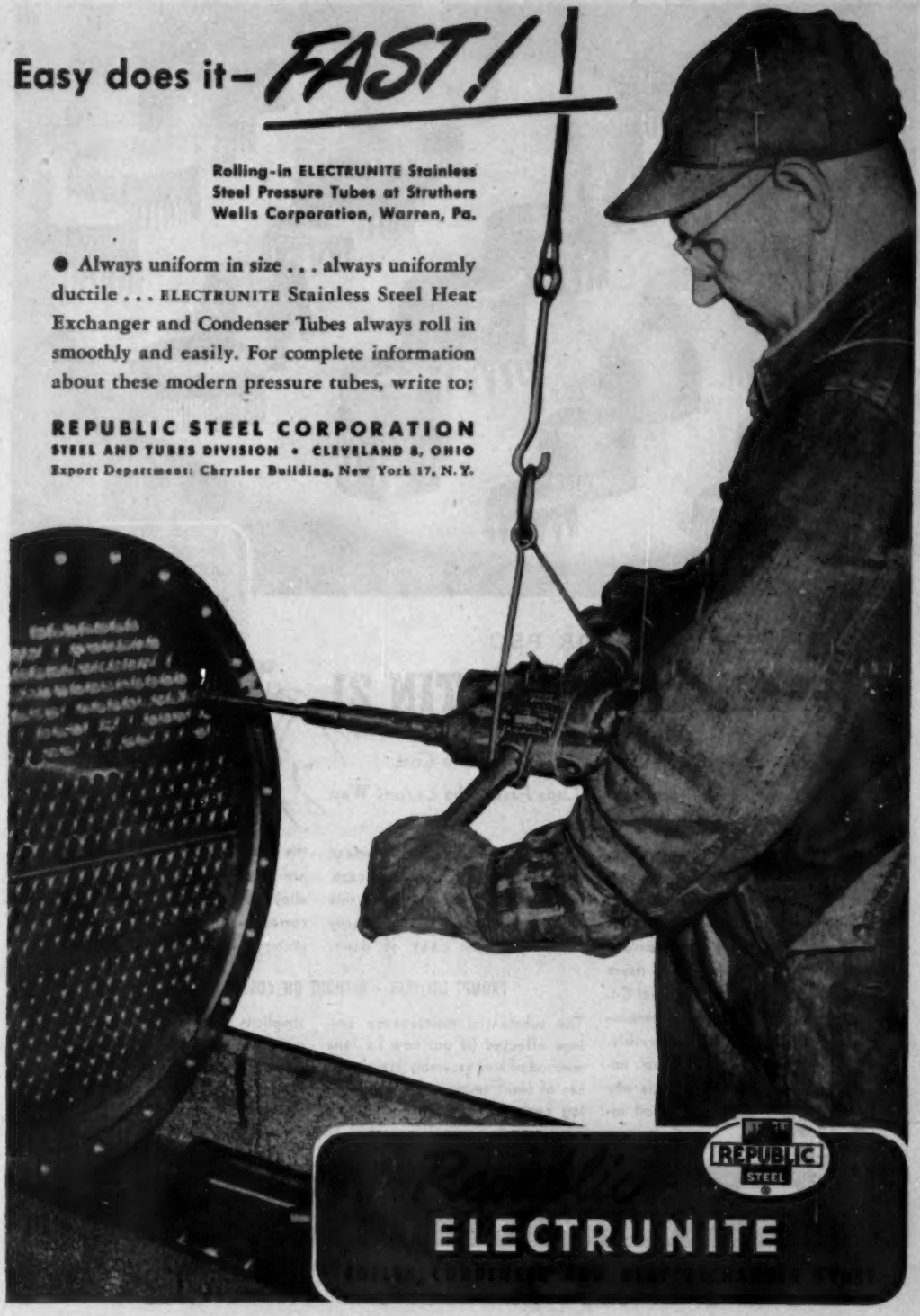

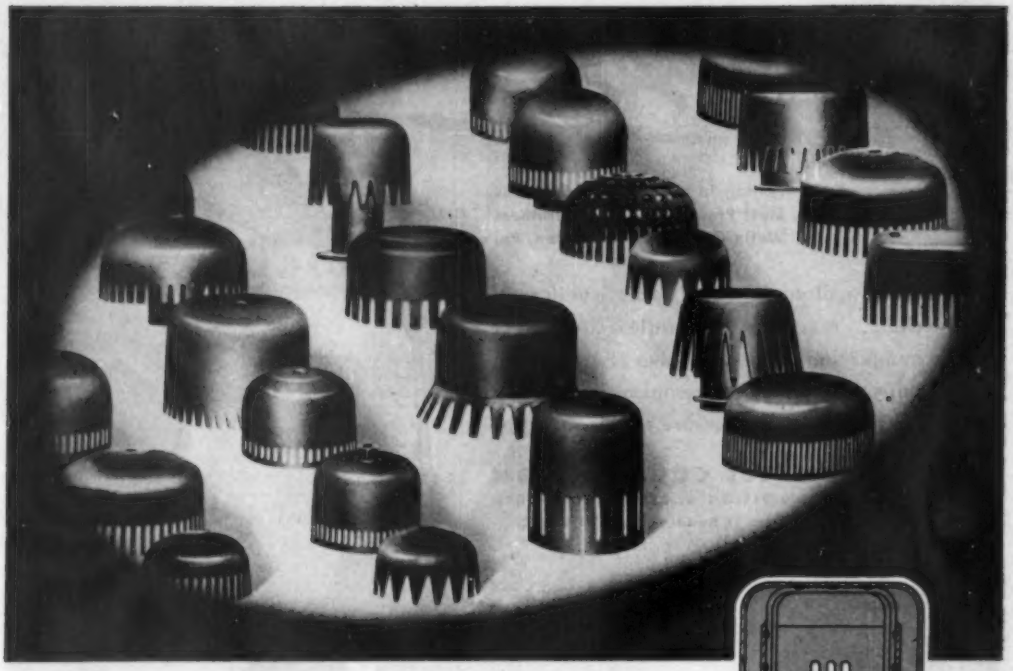

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Lists 200 Standard Styles Furnished Without Die Cost.
How to Install or Remove Caps Faster the LeJons Way.

Just Hammer Wedges In or Out

We believe you will find in PSC Bulletin 21 the largest compilation of engineering data on bubble caps. Complete information is presented for each of the over 200 standard styles of bubble caps and risers furnished by The Pressed Steel Co. Also drawings for use in determining methods of tray assembly. Here are two important reasons why 60% of the oil industry's fractionating equipment are today using PSC bubble caps. First, with dies on hand for this wide range of styles, we save many customers the cost of dies. Second, we fabricate from the complete list of alloys. Thus we are able to use the one particular alloy that best meets your coking or corrosion problems. Special caps promptly designed. Send blue prints

PROMPT DELIVERY · WITHOUT DIE COST · IN ANY ALLOY

The substantial maintenance savings effected by our new LeJons method of tray assembly are a matter of plant record in every refining center. The unprecedented simplicity and tightness of assembly maintain operating efficiency. Inspection and cleanout time is shortened because caps are removed by merely hammering out the wedges.

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Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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25 HP, vertical, explosion proof, double reduction gearmotors make compact, safe, economical drives for these mixers.

GOOD ENOUGH

Don't be satisfied with "good enough" because too often good enough means mediocre. And if the "good enough attitude" becomes too much of a habit it can wreck the future of a man or a company.

Don't put up with "good enough," makeshift assemblies for your power drives when it's so easy to get the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Master Motors, available in thousands and thousands of types and ratings (up to 150 HP), give you an enormous selection of units designed so that they easily combine to give you a power drive that will add greatly to the compactness, safety and economy of each job.

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Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

◆ Does long lasting aluminum cost too much for covering your insulated lines? Not when you specify this new type weatherproof jacketing. It has been specially developed to cost little more than ordinary temporary jacketing materials.

New Low-Cost Jacketing Cuts Maintenance on Insulated Lines

AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in refineries, chemical plants and power plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

Easy application of this Childers Jacketing cuts labor bills drastically. It comes from the factory in easy-to-handle rolls that are four feet wide and either 100 feet or 200 feet long. It is light and flexible to handle as the men put it on the line. No roll forming required as with heavy, un-crimped material. It can be cut off and attached just the same as the old-fashioned tar-paper that was sometimes used for jacketing.

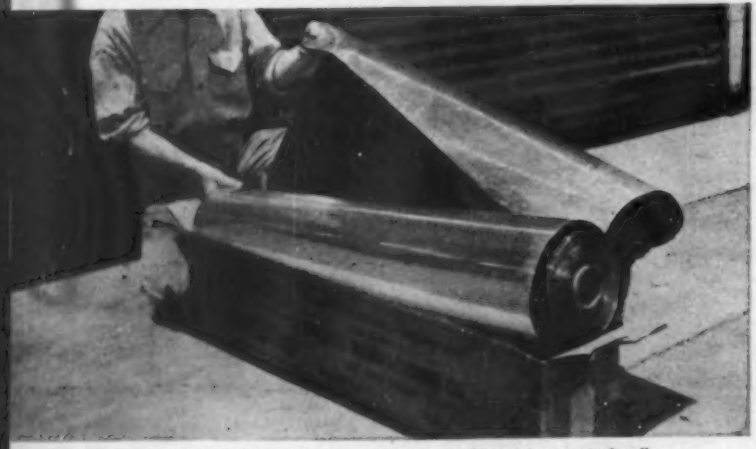
You can attach Childers Jacketing around your insulated lines by one of several easy methods. The use of aluminum strapping and seals is probably the best. Sheet metal screws or Minnesota Mining's No. 471 tape can also be used.

The Childers jacketing can be removed and re-used.

A moisture barrier is attached to the back of the jacketing to give positive protection for the aluminum when it is used with alkaline insulating materials.

No painting, no rust-proofing, little maintenance—that's the advantage of aluminum!

Hundreds of design engineers and maintenance engineers have agreed they save money for their firms and trouble for themselves by changing their jacketing specs to Childers 100%. That should make it worth your testing too—and a test roll costs only $40.00 for 400 sq. ft. (with moisture barrier attached price for 800 sq. ft. without moisture barrier $62.00). That's a good investment in any plant.



This is how Childers Aluminum Jacketing is shipped in easy-to-handle rolls. It is quite flexible, yet stands up under severe weathering.

FOR FULL INFORMATION write Childers Manufacturing Co., Dept. PR-4, 625 Yale St., Houston 7, Tex., for complete literature. Childers has engineering representatives in principal cities to work with you on specific problems.

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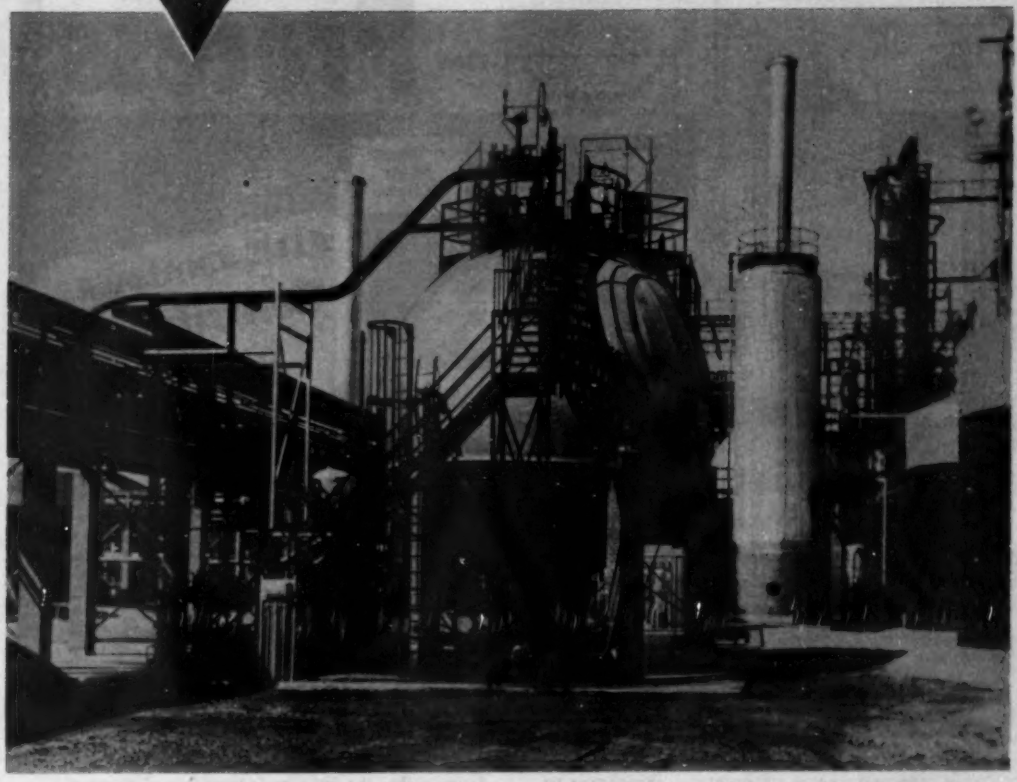
CONOCO another leading refiner who desalts with PETRECO



CONTINENTAL OIL COMPANY is now using Petreco Desalting in four different refineries,—New Mexico, Oklahoma, Texas and Louisiana. Four successive installations by a refining organization with Conoco's established reputation is ample evidence that Petreco Desalting proved itself once for Conoco, and has continued to do so with each successive installation. If you want the best in salt removal performance, specify Petreco and be assured of

Minimum Residual Salts and Solids
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Savings in Salvaged Waste Oil
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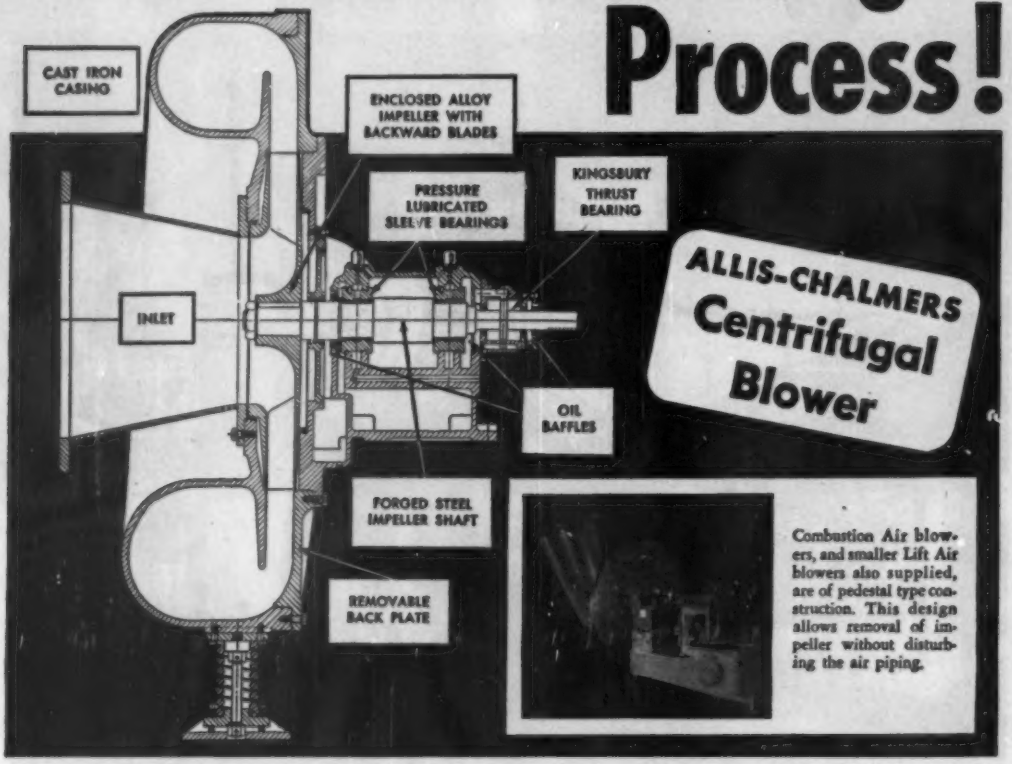
Aids New Cracking Process!



Combustion Air blowers, and smaller Lift Air blowers also supplied, are of pedestal type construction. This design allows removal of impeller without disturbing the air piping.

ALLIS-CHALMERS IS HELPING THE PETROLEUM INDUSTRY in its trend to more efficient cracking methods. Large single stage centrifugal blowers are a vital part of new fluid catalytic cracking processes.

Cross-section drawing and photo above show some of the unusual features of a typical Allis-Chalmers blower used in one of these new refining processes. Rating of Combustion Air blower shown is 34,400 cfm, 3.5 lb G at 3650 rpm.

An important contribution to this blower's high efficiency is made by the special totally enclosed, backward flow, welded alloy steel impeller. The covered design makes the impeller independent of tolerance variations; the backward flow design gives it good pressure, volume and horsepower characteristics.

High strength and long life is assured by all welded alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office.

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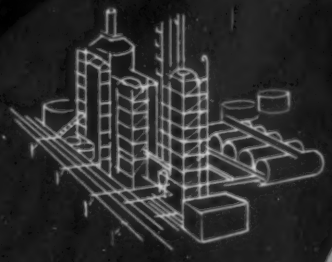
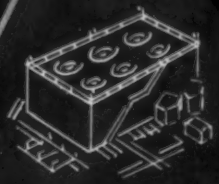


process units



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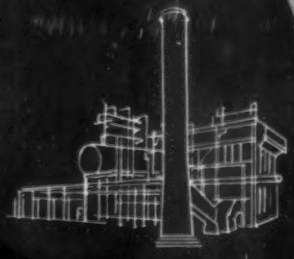
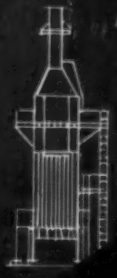


direct-fired heaters



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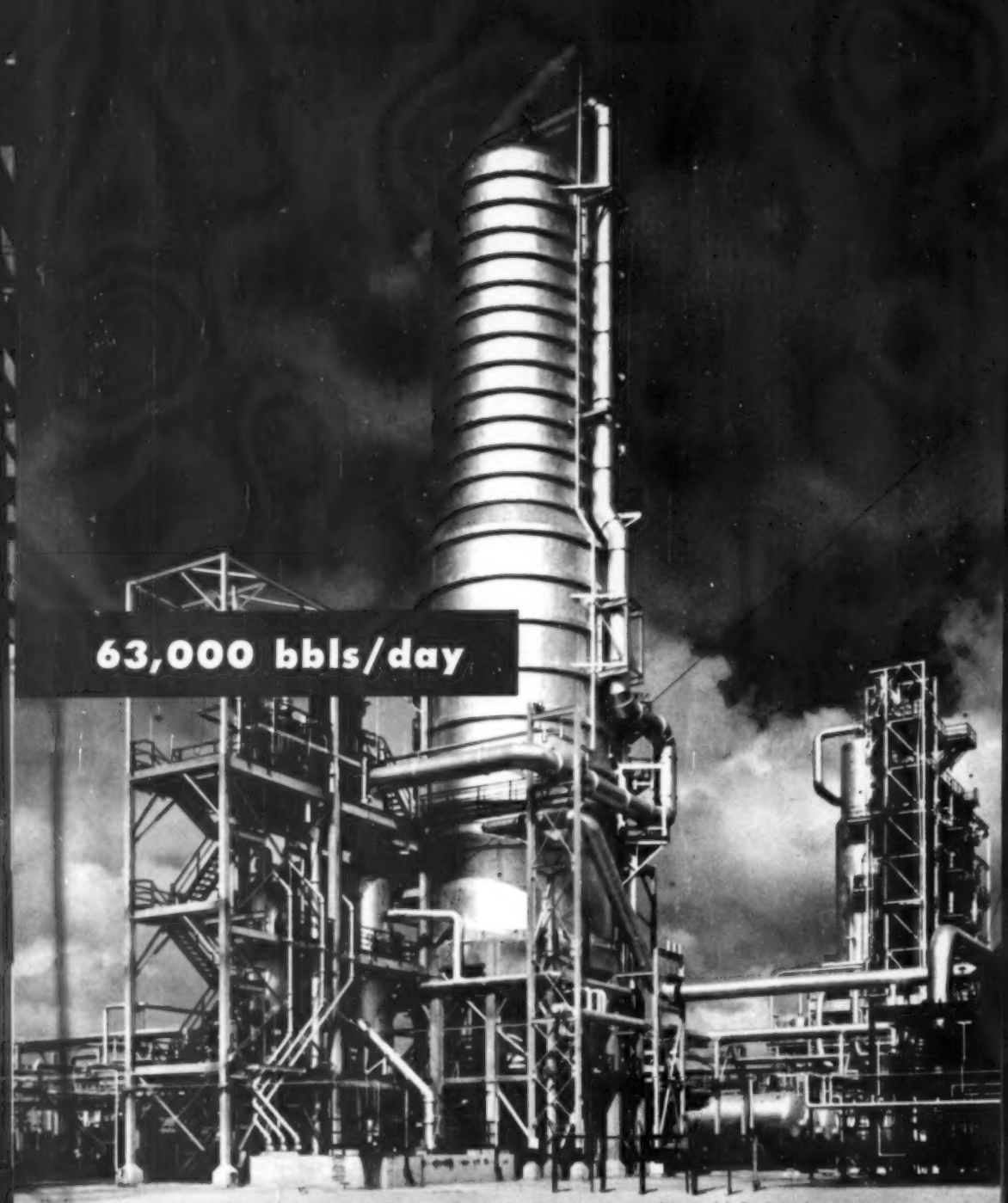

One of the largest 2-stage Crude Distillation units in the world. Designed and constructed by Foster Wheeler, this unit was recently placed in operation at the Amuay Bay, Venezuela refinery of the Creole Petroleum Corporation.

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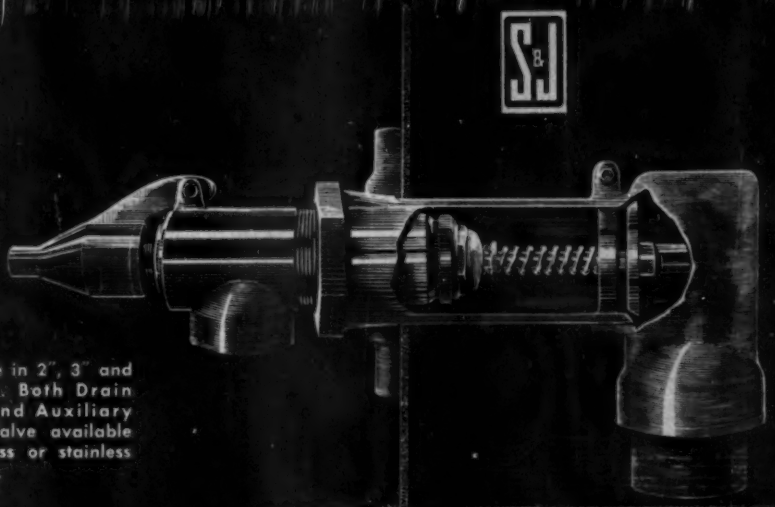
The S&J Anti-Freeze Drain Valve, illustrated in the drawing below, was designed to draw water off the bottoms of petroleum storage tanks, and remain operable during sub-freezing weather conditions. This is accomplished by constructing the internal parts of the valve to be self draining. If water will not remain inside the valve body, obviously the valve cannot freeze up and become inoperative.

In the illustration of Model ST-2001-AV shown below, the Anti-Freeze Drain Valve is screwed into an auxiliary shut-off adapter sleeve, which permits removal of the valve from the tank without having to drain its contents. With the valve functioning, manual operation opens the auxiliary to give full flow characteristics; closed, the auxiliary is also self draining.



Available in 2", 3" and 4" sizes. Both Drain Valve and Auxiliary Safety Valve available with brass or stainless steel trim.

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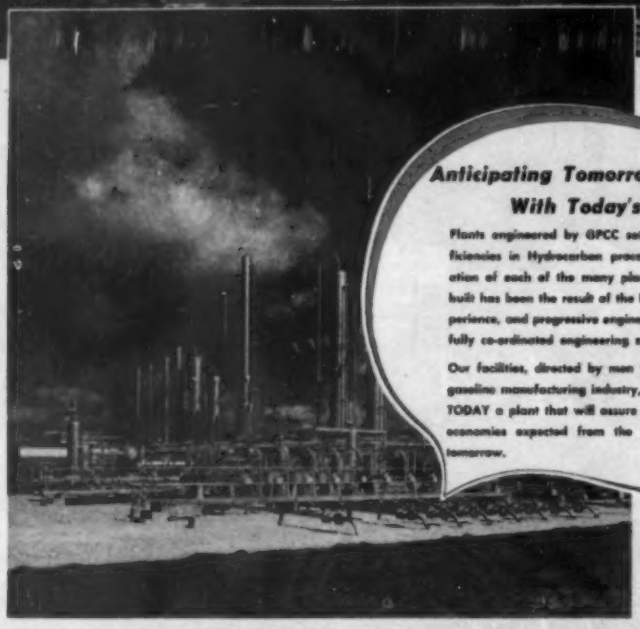
WITH AN EYE TO THE FUTURE



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IN THIS new Pressure Vessel Catalog 501 you will find the latest data covering pressure vessel outlets compiled as you would expect it to be by the originators of forged and rolled steel welding necks and nozzles.

The pages include up-to-the-minute information on seamless steel nozzles, welding necks, manways, and large diameter flanges for boilers, heat exchangers, and other pressure vessels. Of particularly timely importance are data covering standards of Tubular Exchangers Manufacturers Association (TEMA Standards). A useful section on modern flange design covers codes, materials, and design procedures with typical calculation forms and examples of calculation.

This 118 page book is available without charge to anyone having a specific interest in outlets for pressure vessels. To obtain your copy see your Taylor Forge Distributor or **MAIL THE COUPON.**

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2 **Stop stem wear and allow full flow.** Long guide on Sims rotator lets valve open evenly—does not cock up on one side. Rotator controls rotation of valve disc to increase service life—protect spring against crushing.

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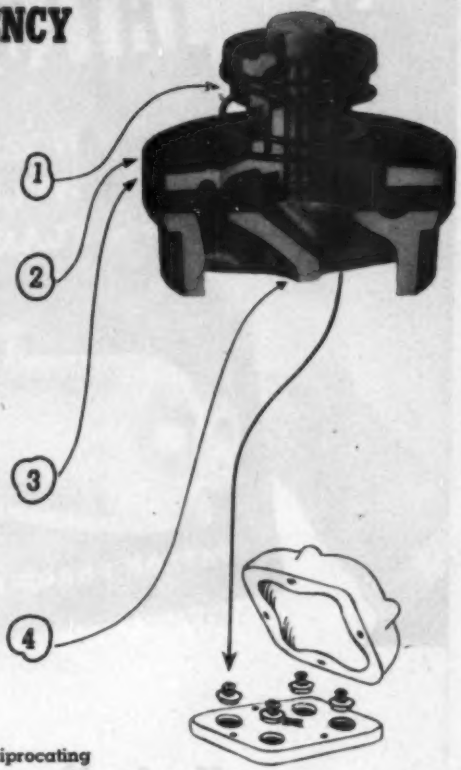
4 **Allow maximum flow with absolute minimum resistance through valve seat.** Exclusive inclined rib design permits complete filling of cylinders—reduces valve slam and knock—adds to long life of valve parts.



Sims valves are made in sizes from 2¾" to 15¼" to fit any reciprocating pump. Valves supplied ready to install—cast in individual units or in complete plates.

New catalog shows how Sims valves fit any pump—how they work—efficiency and comparison charts. Send for your free copy today.

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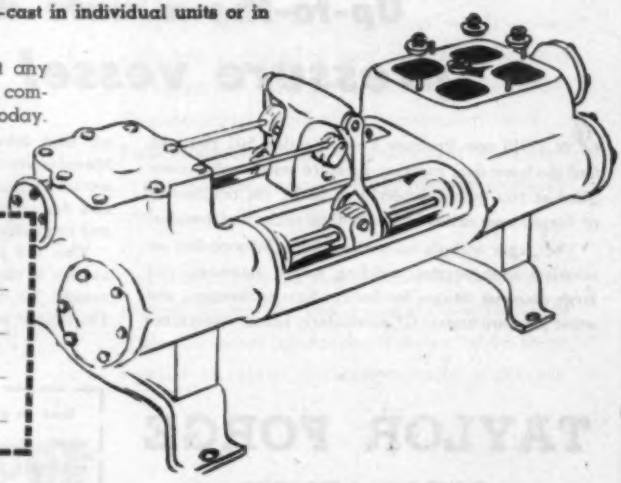

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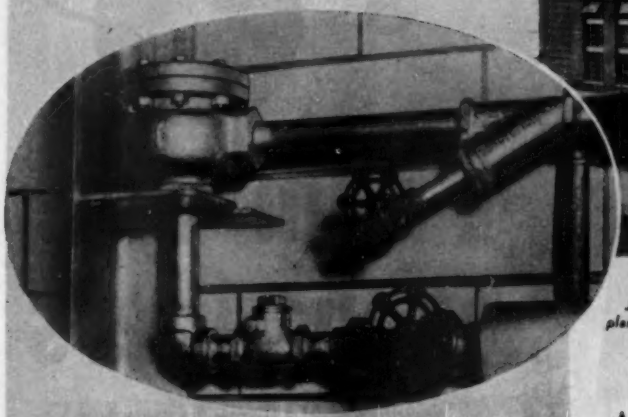
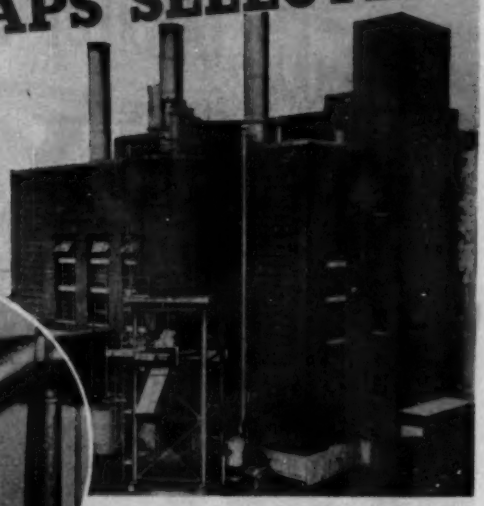
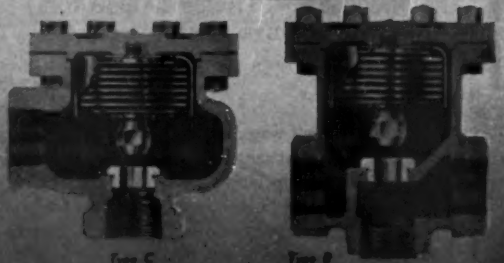
NICHOLSON TRAPS SELECTED

for Jeffrey's Ultra-Modern Boiler Plant...



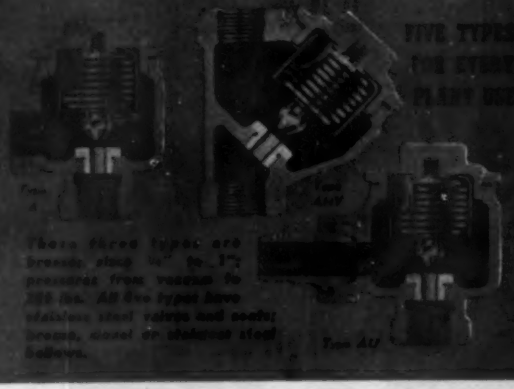


Above, the new ultra-modern boiler house of Jeffrey Manufacturing Co. at its Columbus, Ohio, plant. Specified were Nicholson Steam Traps, one installation of which is shown at left returning main steam header condensate to heater.



Type C Type B

The two types above are cast iron; sizes ½" to 2"; pressures from vacuum to 225 lbs. Type C also in cast steel for pressures to 300 lbs.



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Type A Type AU

These three types are bronze, sizes ½" to 1"; pressures from vacuum to 250 lbs. All five types have stainless steel valves and seats; bronze, monel or stainless steel bellows.

As leading makers of power house equipment, when The Jeffrey Manufacturing Co. set out to build a new boiler house for their own 48-acre plant in Columbus, Ohio, the project obviously became a subject of peculiar pride. Recently completed at a cost of over a million dollars to handle steam loads up to 180,000 lbs. per hour, the new plant is saving $40,000 annually.

Since Jeffrey's new plant is considered probably the most modernly equipped, the choice of Nicholson steam traps is naturally significant. A recent survey showed these Nicholson features to be reasons why an increasing number of leading plants are standardizing on Nicholson thermostatic traps: 2 to 6 times average drainage capacity; shorten heat-up time. Operate at lower temperature differential; fast action keeps equipment full of live steam. Maximum air-venting capacity. Types for every process, power and heat application.

Catalog 250 contains capacity tables, installation diagrams, and data, charts and formulae for determining the proper size trap.

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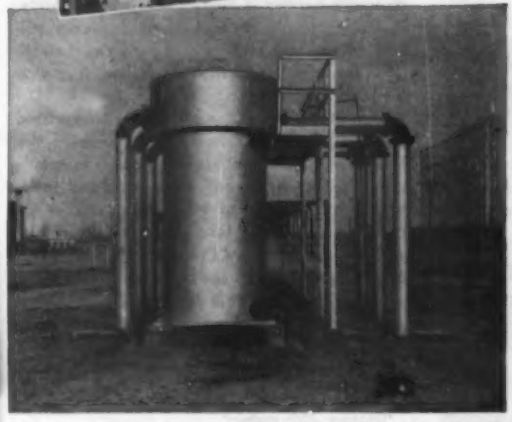
film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,500 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

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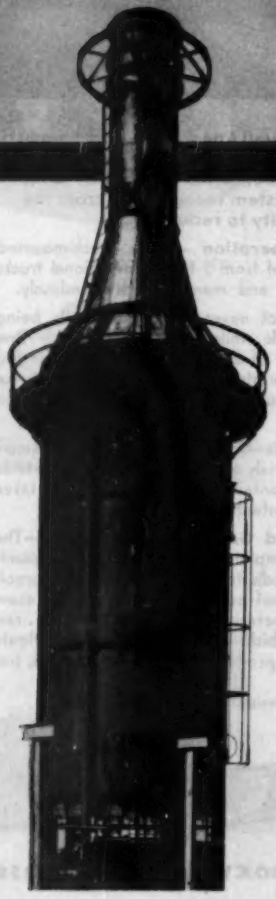
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



It is significant that as Canada's petroleum industry expands, more and more Petro-Chem Iso-Flow Furnaces are called upon to meet the increasing requirements of oil refineries, pipe lines, gas plants and allied chemical industries... in Canada, as throughout the world, Petro-Chem Iso-Flow Furnaces are demonstrating the unique and superior features inherent in their design.

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● **The General Electric Company, well known for sound management, is among the hundreds of cost-minded manufacturers using the Dempster-Dumpster System of bulk materials handling . . . the system recognized across the nation for its efficiency and ability to reduce costs!**

Cuts Cost of Equipment and Operation — One truck-mounted Dempster-Dumpster performs the work of from 3 to 5 conventional trucks . . . reducing investment, maintenance and man hours tremendously.

Eliminates Standing Idle Time—Truck never stands idle while being loaded nor do loading crews stand idle while truck makes haul. One Dempster-Dumpster services any number of detachable containers ranging in size up to 12 cu. yds. and in a wide variety of designs best suited to the type of materials handled—be they bulky, light or heavy . . . solids, liquids or dust . . . trash or rubbish.

Eliminates Re-Handling of Materials—Dempster-Dumpster Containers are placed at the very spot where materials accumulate—inside or outside buildings. Materials placed in these containers remain there until taken to destination and dumped or set down intact.

Increases Efficiency, Sanitation and Good "Housekeeping"—The Dempster-Dumpster System is a complete, unified plan for plant-wide cleanliness. Containers built to handle trash and refuse are fire-proof, rat-proof and fly-proof. Contents cannot be scattered by wind or scavengers. Regardless of your particular materials handling problem . . . raw products, finished products, trash or rubbish—it will pay you to investigate the Dempster-Dumpster System now! A product of Dempster Brothers, Inc.

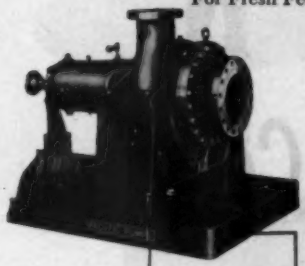
One Dempster-Dumpster Services All Containers. . . All Designs. . . All Sizes

DEMPSTER BROTHERS, 541 Dempster Bldg., Knoxville 17, Tennessee

RECORD BREAKING
PERFORMANCE PROVED
Pacific
Precision Built PUMPS

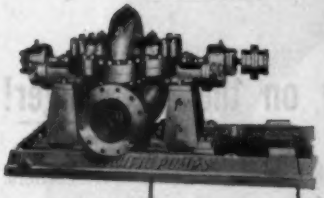
WERE SELECTED FOR THE WORLD'S LARGEST "CAT"*

For Fresh Feed • Hot Bottoms • Hot Reflux • Slurry Reflux • Recycle • Decanted Oil



TYPE SV SLURRY

TYPE SVC



TYPES DH-KH

TYPE WY

Pacific Pumps are serving "cats" the world over. Because they are Precision Built from materials selected for the specific service. They have established the most outstanding records for continuity of operation with sustained economy.

- Light and Heavy Gas Oils
- Recycle—Reflux
- Stripper Bottoms
- Debutanizer Feed —Reflux
- Depropanizer Feed —Reflux
- Boiler Feed
- Surface Condenser Condensate

WRITE FOR BULLETINS

* *Name on request*

PACIFIC *Precision Built* PUMPS

Pacific Pumps inc.

HUNTINGTON PARK, CALIFORNIA

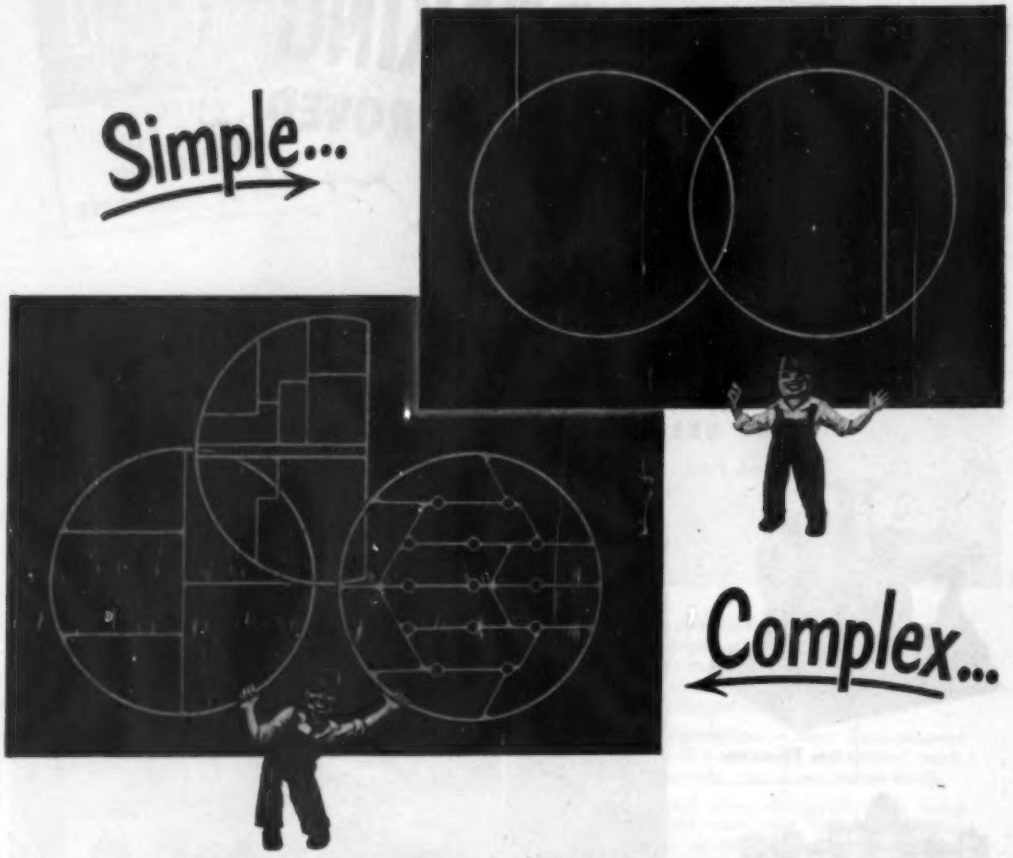
Export Office: Chanin Bldg., 122 E. 42nd St., New York

Offices in All Principal Cities

PR-12

Precision-made to the design you need . . .

Simple...



Complex...

Goetze Heat Exchanger Gaskets stay on the job longer!

Whether your specifications call for a simple or complex design, you can depend on Johns-Manville Goetze heat exchanger gaskets to do the kind of sealing job that costs you less in the long run!

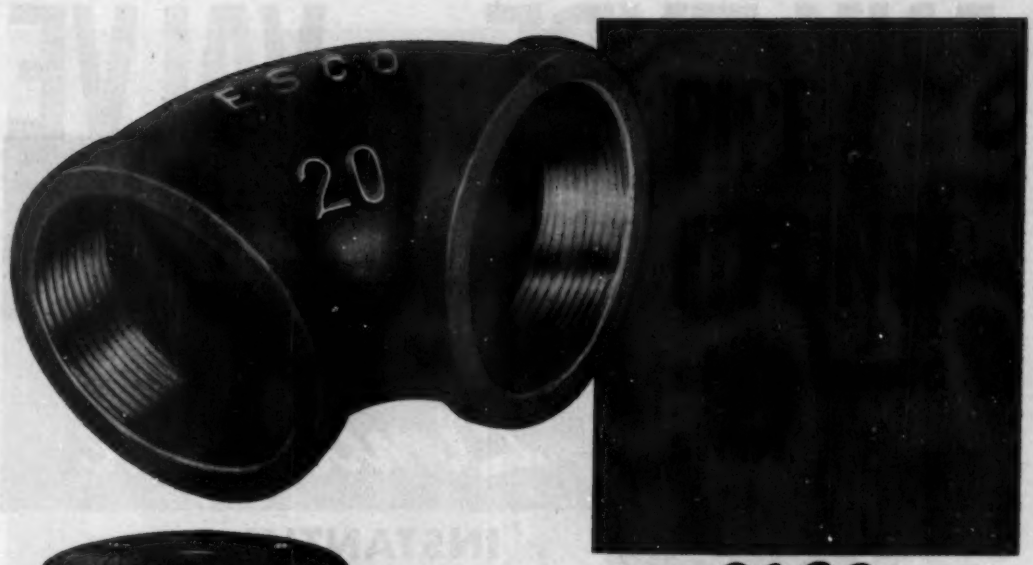
That's because they are carefully hand-tailored to assure the accuracy of fit so important in heat exchanger service. Every detail of construction reflects the craftsmanship that goes into the fabrication of these better gaskets. You'll find no wrinkles or cracks on the corners. Lap widths are ample, rib widths uniform.

More than 60 years of gasket-making experience is your further assurance that when you put a Goetze heat exchanger gasket on the job, you can count on it to *stay* on the job for a long time. For further details and a prompt estimate of cost, send us a blueprint or template. Just address Johns-Manville, Box 290, New York 16, New York.

JM

Johns-Manville Goetze GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE



by ESCO

Made in corrosion-resistant analyses
Permanent identification "cast-in"
Precision-made for accurate alignment
Properly proportioned
Rigidly inspected and tested for long service.

Cast with heavy wall sections in a variety of analyses, *ESCO* stainless pipe fittings are a vital part of corrosion resistant piping.

Screwed fittings are carried in warehouse stocks in sizes ranging from ⅛" to 4". Available in 90- and 45-degree elbows, tee, cross, union, coupling, reducer, plug, bushing and locknut.

Flanged fittings are produced in sizes from 1" to 14" in 90- and 45-degree elbows, tee, long radius ell, 45-degree lateral and reducer.

Special sizes and types are produced to engineering specifications.

Ask for Fittings Catalog

ESCO pipe fittings are shown with detailed information in catalog 186. Your nearest *ESCO* representative will gladly give you a copy; or use the coupon.

ESCO STAINLESS AND HIGH ALLOY STEELS

ELECTRIC STEEL FOUNDRY

2181 N. W. 25th Avenue, Portland 10, Oregon

SALES OFFICES AND WAREHOUSES:

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ELECTRIC STEEL FOUNDRY
2181 N. W. 25th Avenue, Portland 10, Oregon
Please send catalog No. 186 to

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ANY TYPE OF VALVE

any place, any time, by any power-source available

CAN BE OPERATED BY *Limitorque*

Limitorque can always be declutched for handwheel operation regardless of weather or electrical conditions.

- ✓ **INSTANTLY**
- ✓ **ACCURATELY**
- ✓ **SAFELY**
- ✓ **DEPENDABLY**

LimiTorque opens and closes valves of all makes and types up to 96" diameter by the "push of a button" from either remote or nearby control panels. Damage to stem, seat, disc, gate or plug is prevented because the Torque Seating Switch *limits the torque*, shuts off the motor if an obstruction occurs.

Greater safety is afforded workmen by LimiTorque Remote Control as it is unnecessary to go to high, low or dangerous locations for manual operation.

LimiTorque may be actuated by any available power source . . . electricity, steam, water, gas, oil or air.

LimiTorque Controls are obtainable through valve manufacturers. Thousands in daily use on land and sea . . . in Power Plants, Central Stations, Water Works, Refineries, and Oil Pipe Lines.

For full details . . . write for Catalog L-50 — please use your Business Letterhead.

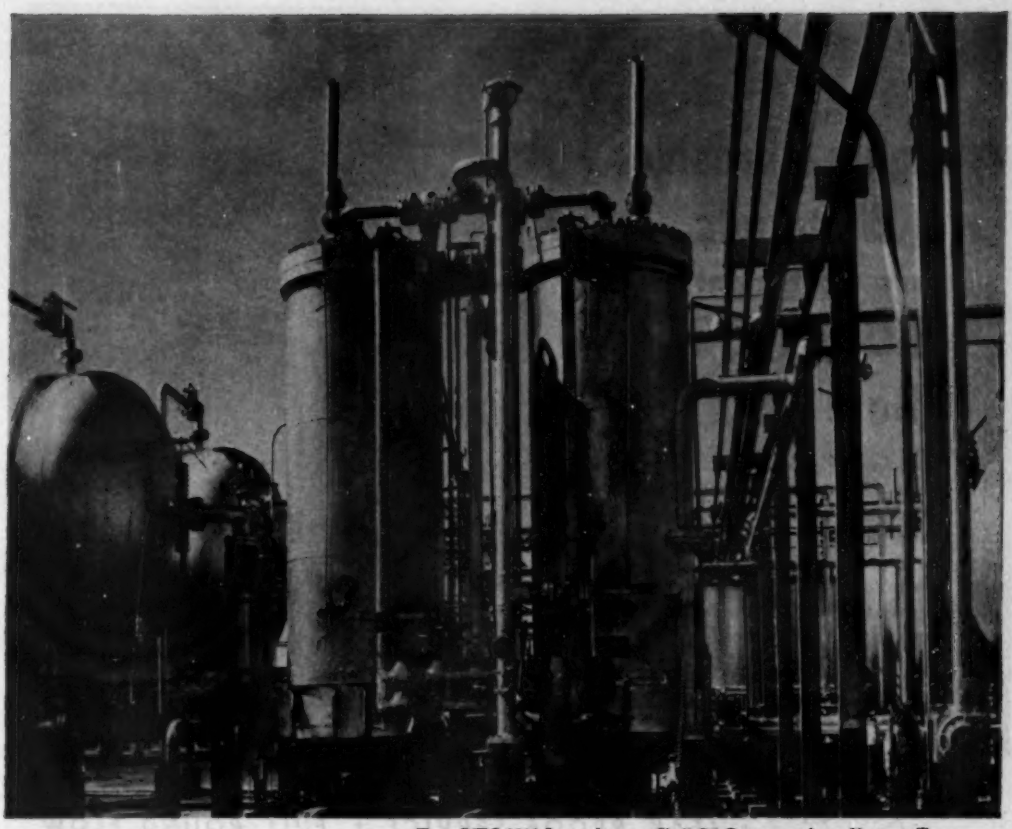
Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls



Type BWC-3500 Lectrodryer at Shell Oil Company plant, Notrees, Texas.

DRYing propane at SHELL

Lectrodryers catch the moisture which separators and filters let by, DRYing hydrocarbons in either the liquid or gaseous stage. In this Shell Oil Company installation, liquid propane is processed.

Hydrocarbons for chlorination must be DRY, to prevent vicious attack of the steel in the chlorinators. Lectrodryers are placed on-stream to DRY them, therefore, as they pass on for further processing.

Hydrocarbons must be DRY before being fed into reactions where HF is the catalyst. And, in many cases, the purchaser specifies a DRY hydrocarbon for reasons of his own. Lectrodryers are doing all those DRYing jobs.

You can get extreme DRYness with Lectrodryers —down to 3 to 4 parts per million or less. Our engineers will help you lay out the system and select the proper equipment. For this help, write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

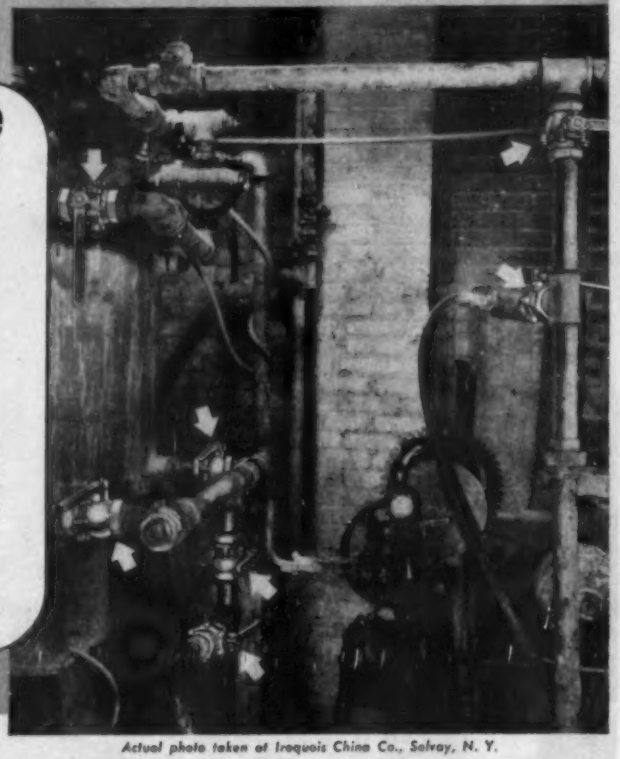
LECTRODRYER

REGISTERED TRADEMARK U. S. PAT. OFF.

Highly Abrasive Materials

are no threat to ROCKWOOD Ball VALVES

Foreman at Iroquois China Company, Solvay, New York, says "Rockwood Ball Valves are operated 40 times a day handling a mixture of clay and water. Each Valve has performed better, operated easier and lasted longer than any other valve we ever used."



Actual photo taken at Iroquois China Co., Solvay, N. Y.

• LEAK PROOF SERVICE • FULL ROUND FLOW
• EASY TO OPERATE • NO MAINTENANCE

The Rockwood Ball Valves shown in this picture are installed on a slip machine and lines. They are operated 40 times daily and handle a mixture of clay and water. This mixture, called "slip", is highly abrasive. Yet, under this severe condition, Rockwood Ball Valves have been in operation for over 14 months — longer than any other valves ever used — and during that time, have never required attention. Men using the Rockwood valves claim they operate easier and faster and a glance tells whether valves are opened or closed.

When using the conventional type valve, the Iroquois China Company found the turbulence created in the valve would add air to the "slip" and cause pin holes in the finished product. Also, the "slip" would accumulate in the bonnet and prevent full opening and tight closing. Rockwood Ball Valves eliminate this trouble. Rockwood Ball Valves are also successfully performing on glaze operations, where a mixture of ground glass and water is used.

The full round opening of the Rockwood Valves do not permit turbulence. Design of the resilient synthetic rubber seat in combination with the hard chromium floating ball makes Rockwood Ball Valves stay tight when closed.

A valve with these qualities will give top notch performance in your plant — why not install one today and be convinced.

Rockwood valves are recommended for 300 p.s.i. working pressure and are available in all pipe sizes from ½" to 4". They are today giving service in oil refineries, food, paper, textiles, chemical and rubber plants, etc.

Distributors in all principal cities.

ROCKWOOD SPRINKLER CO
102 HARLOW STREET WORCESTER 5, MASS

Think of this sign first . . . . . .

for Ethylene

Manufacturing Facilities

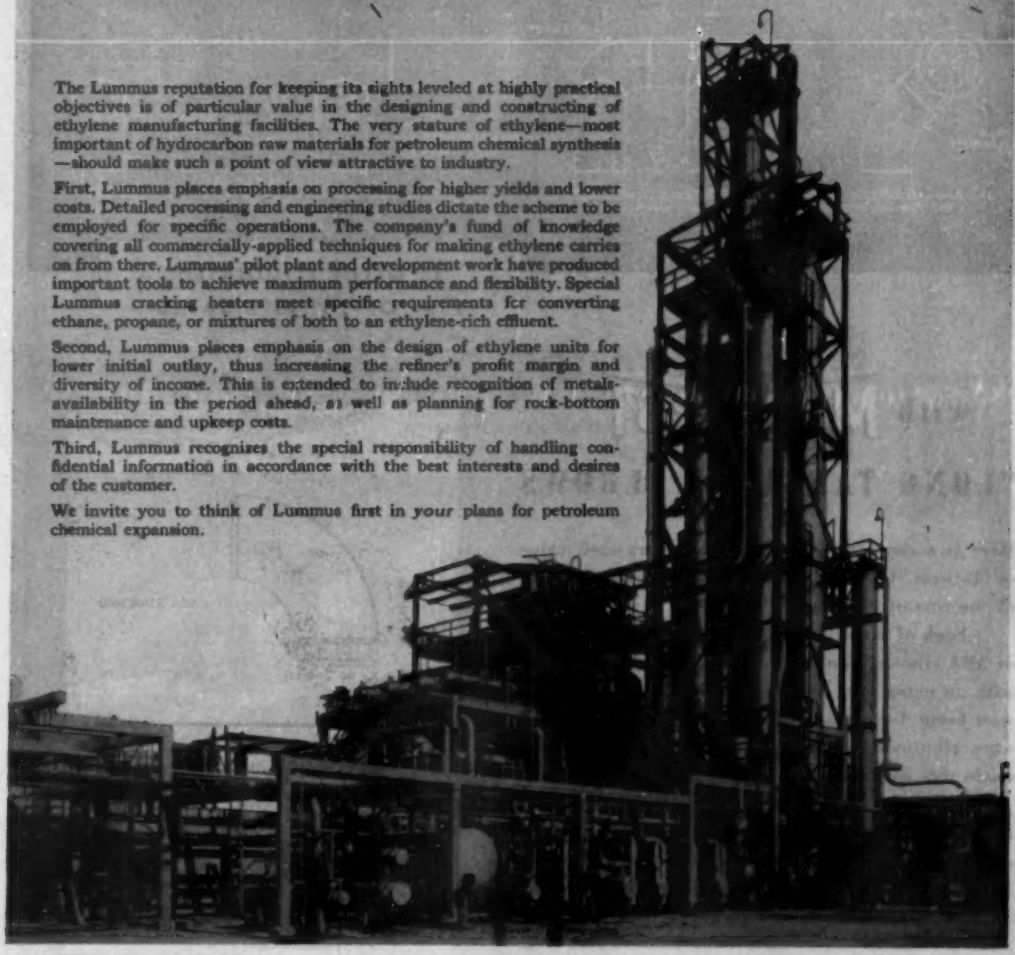
The Lummus reputation for keeping its sights leveled at highly practical objectives is of particular value in the designing and constructing of ethylene manufacturing facilities. The very stature of ethylene—most important of hydrocarbon raw materials for petroleum chemical synthesis—should make such a point of view attractive to industry.

First, Lummus places emphasis on processing for higher yields and lower costs. Detailed processing and engineering studies dictate the scheme to be employed for specific operations. The company's fund of knowledge covering all commercially-applied techniques for making ethylene carries on from there. Lummus' pilot plant and development work have produced important tools to achieve maximum performance and flexibility. Special Lummus cracking heaters meet specific requirements for converting ethane, propane, or mixtures of both to an ethylene-rich effluent.

Second, Lummus places emphasis on the design of ethylene units for lower initial outlay, thus increasing the refiner's profit margin and diversity of income. This is extended to include recognition of metals-availability in the period ahead, as well as planning for rock-bottom maintenance and upkeep costs.

Third, Lummus recognizes the special responsibility of handling confidential information in accordance with the best interests and desires of the customer.

We invite you to think of Lummus first in *your* plans for petroleum chemical expansion.



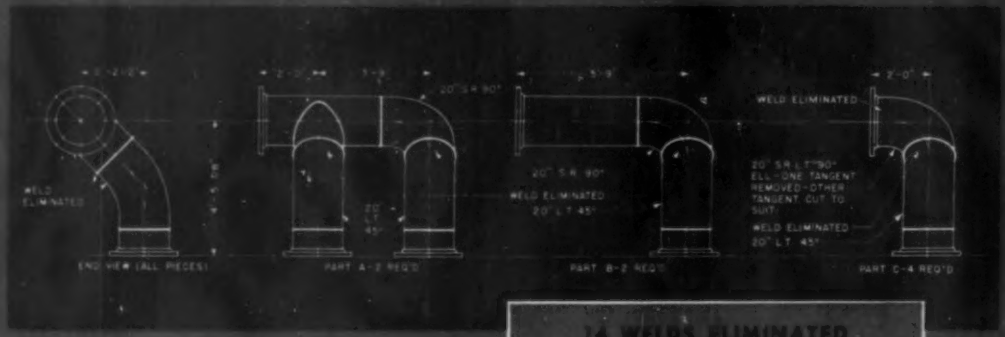
THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

CHICAGO • HOUSTON • LONDON • CARACAS • PARIS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

12% COST REDUCTION... *in these piping subassemblies*



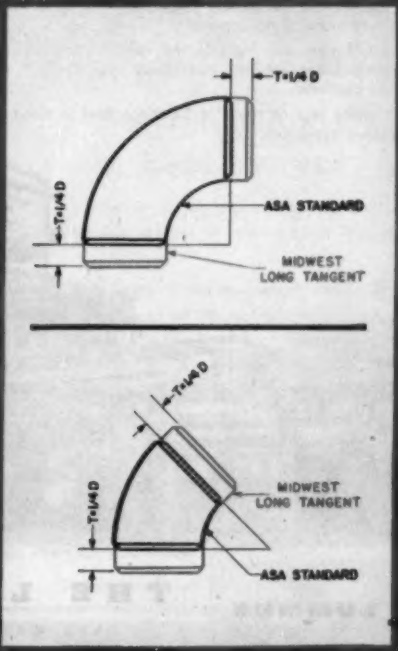
14 WELDS ELIMINATED
9'-8" OF 20" PIPE SAVED

with MIDWEST "LONG TANGENT" ELBOWS

Here is a concrete example of the extra cash value of Midwest "Long Tangent" Elbows. They saved 12% of the cost of this piping.

Each of the subassemblies shown above, if made of ASA elbows, would have required an extra nipple with an extra weld at the dotted line. With the Midwest Long Tangents, both the nipples and the welds were eliminated. Reduced material and labor costs made this substantial saving.

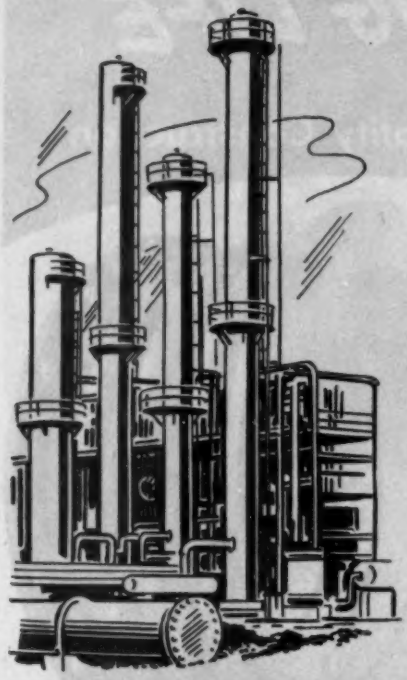
Other advantages of Midwest "Long Tangent" Elbows: pipe and fitting lined up more quickly and accurately, weld is removed from point of maximum bending stress, can be observed, slip-on welding flanges are more easily used, and they cost no more than standard elbows usually furnished. Ask for Catalog 48.



MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs

MIDWEST PIPING & SUPPLY COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Pocatello, Los Angeles and Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St. Los Angeles 33—820 Anderson St. • Houston 2—1213 Capitol Ave. • Tulsa 3—324 Wright Bldg. • Boston 27—426 First St.

A "NATURAL" for GASOLINE PLANTS



. . . the triple-thrifty

Ingersoll-Rand Turbo-Blowers

✓ LOW IN POWER COSTS
✓ LOW IN MAINTENANCE
✓ HIGH IN AVAILABILITY

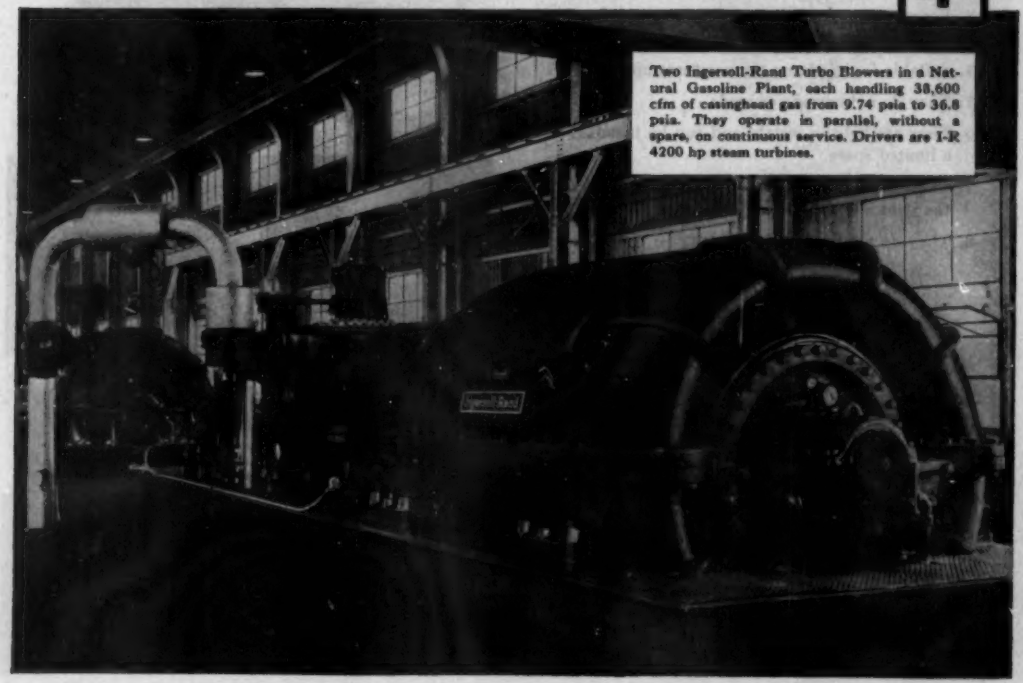
In Natural Gasoline Plants, Catalytic Cracking units, and wherever large volumes of air or gas must be compressed to moderate pressures, over 3,000,000 horsepower of Ingersoll-Rand Turbo-Blowers are repeatedly proving their economy and dependability.

They save on *power costs* – through higher sustained efficiency, year after year. They save on *maintenance* – because they require less of it, even under the most severe operating conditions. And their high *availability* avoids costly shut-downs – keeps them earning money by maintaining maximum production.

Whatever your blower application, Ingersoll-Rand can design and supply the Turbo-Blower that's right for the job—a blower you can depend on for constant delivery of air or gas at the lowest cost. Sizes: to 21,000 hp, to 110 psig and higher, to 155,000 cfm.

Ingersoll-Rand
11 Broadway, New York 4, N. Y. 352-12

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS
CONDENSERS • CENTRIFUGAL PUMPS • DIESEL & GAS ENGINES



Two Ingersoll-Rand Turbo Blowers in a Natural Gasoline Plant, each handling 38,600 cfm of casinghead gas from 9.74 psia to 36.8 psia. They operate in parallel, without a spare, on continuous service. Drivers are I-R 4200 hp steam turbines.

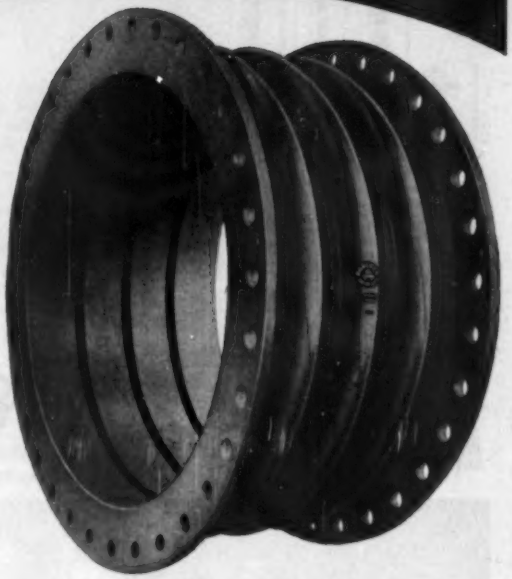
EXTRA LONG LIFE

—Because of *Quality* Construction

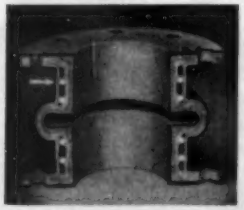
GARLOCK Rubber Expansion Joints are made of a high-grade rubber compound specially developed by Garlock for long, economical service on pipe lines and other equipment. Furnished in three styles: No. 204 for *Pressure*, No. 205 for *Vacuum*, and No. 206 for *Pressure and Vacuum*. Available in neoprene construction for oil service.

8 Superior Features:

1. Made of high-grade rubber, they do not crack or fracture under repeated flexing.
2. They do not take a permanent set.
3. For pressures from 40 to 125 p.s.i.; and for vacuum of 30 in. of mercury.
4. Suitable for operating temperatures up to 180°F.
5. They do not corrode or erode.
6. They are light in weight and can be installed in a limited space.
7. They require no gaskets between the flanges of the joint and the flanges of the pipe.
8. They do not induce electrolysis.



Garlock "multiple arch" Rubber Expansion Joint.



Arrow points to one of steel reinforcing rings in single arch joint.

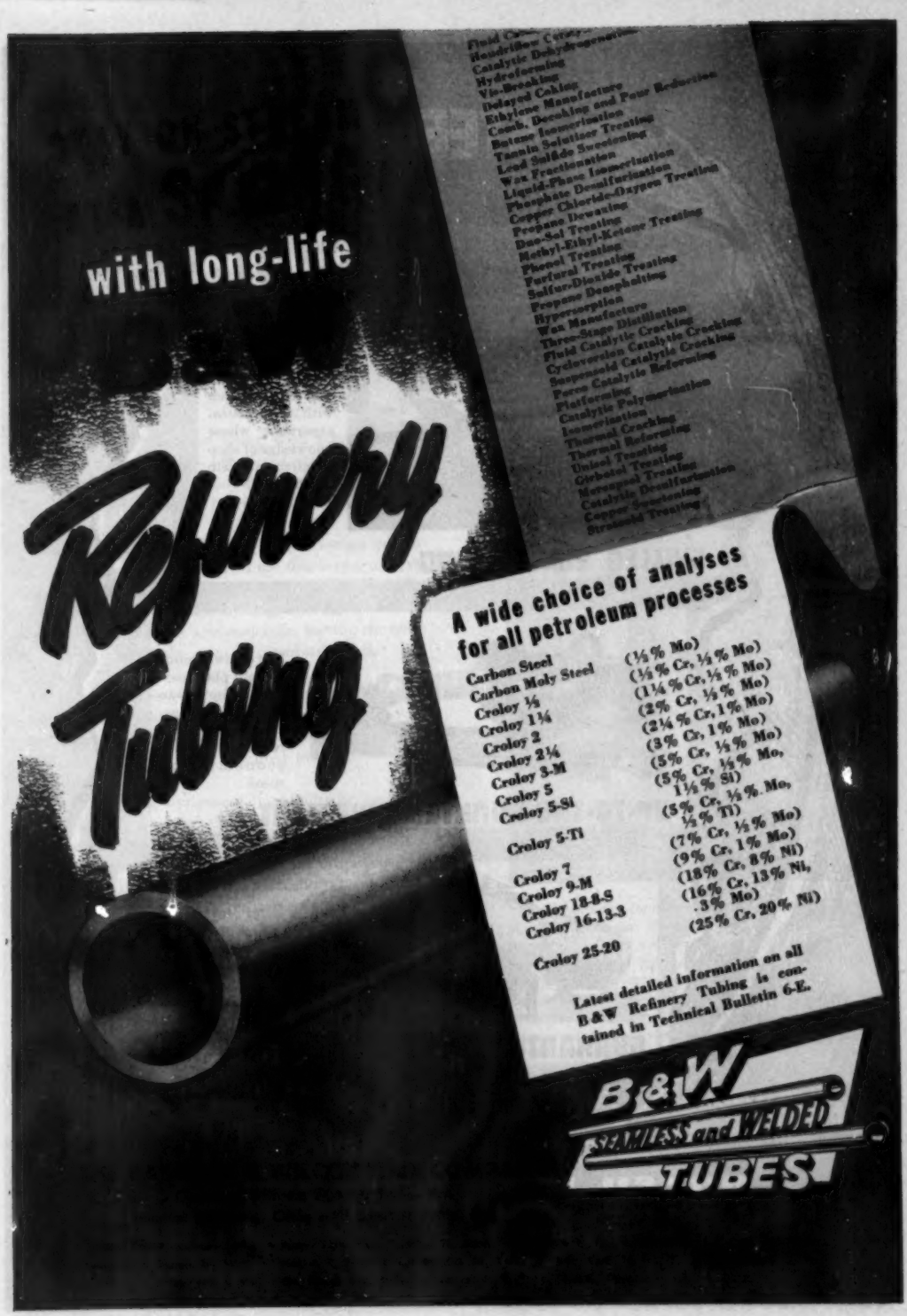
Garlock expansion joints are furnished in all pipe sizes from 8" to 72".

Write for Folder.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

Tulsa, Okla. Houston, Tex.
Los Angeles, Calif.

GARLOCK RUBBER EXPANSION JOINTS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Comb. Decoking and Pour Reduction
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Lead Sulfide Sweetening
Wax Fractionation
Liquid-Phase Isomerization
Phosphate Desulfurization
Copper Chloride-Oxygen Treating
Propane Dewaxing
Duo-Sol Treating
Methyl-Ethyl-Ketone Treating
Phenol Treating
Furfural Treating
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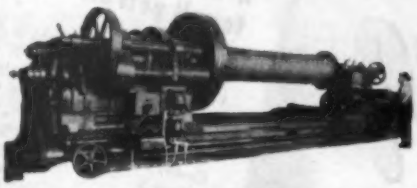
Copper Sweetening
Stratasol Treating
A wide choice of analyses for all petroleum processes
Carbon Steel (½% Mo)
Carbon Moly Steel (½% Cr, ½% Mo)
Croloy ½ (1¼% Cr, ½% Mo)
Croloy 1¼ (2% Cr, ½% Mo)
Croloy 2 (2¼% Cr, 1% Mo)
Croloy 2¼ (3% Cr, 1% Mo)
Croloy 3-M (5% Cr, ½% Mo)
Croloy 5 (5% Cr, ½% Mo, 1½% Si)
Croloy 5-Si (5% Cr, ½% Mo, ½% Ti)
Croloy 5-Ti (7% Cr, ½% Mo)
Croloy 7 (9% Cr, 1% Mo)
Croloy 9-M (18% Cr, 8% Ni)
Croloy 18-8-S (16% Cr, 13% Ni, .3% Mo)
Croloy 16-13-3 (25% Cr, 20% Ni)
Croloy 25-20
Latest detailed information on all B&W Refinery Tubing is contained in Technical Bulletin 6-E.
B&W
SEAMLESS and WELDED
TUBES

POSEY'S STEEL PLATE STORY *in a Nutshell*

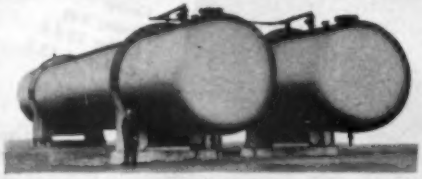
Posey's engineering department is staffed by men with long *practical* experience whose knowledge of shop requirements help end delays.

SKILLED ENGINEERING



Extensive, modernized plant permits Posey Iron to meet both "special" and standard requirements with economy and *speed*.

UP-TO-THE-MINUTE EQUIPMENT



Posey equipment is often delivered with *performance* guaranteed. All standard codes are met with liberal allowance for safety.

GUARANTEED PERFORMANCE

POSEY IRON WORKS, Inc.

STEEL PLATE DIVISION LANCASTER, PA.

TANKS . . STACKS . . . GENERAL STEEL PLATE CONSTRUCTION

ALL-METAL EQUIPMENT USED TO PRODUCE DE-IONIZED WATER

Mineral content reduced to less than 10 parts per million

The equivalent of distilled water, with a mineral content of less than 10 ppm—a 96% reduction—is flowing from the all-Monel de-ionizing system at the Swansboro Ice Company, Swansboro, North Carolina.

This equipment operates on the two-stage cation- and acid-removing principle. In the first stage, mineral salts are converted to their equivalent acids by exchanging the original cations for hydrogen ions. The second stage removes the entire acid molecule, leaving the effluent water free from the original dissolved solids.

This is the only process, other than distillation, which removes all ions from water. But since such high purity water is obtained by de-ionization, even a trace of metal pick-up can seriously alter the final purity.

Therefore, metal equipment used must be virtually inert to the water carried through it. For several years, piping and fittings of Monel had been used in de-ionization, but it was not realized that entire units could be made of Monel. Then, with the Swansboro installation, it was proved that Monel's resistance to water was so high that metal pick-up from it would affect water purity negligibly, if at all.

After the equipment had been in use for an entire summer, producing 500 gallons of de-ionized water an hour, the fabricator, Hungerford & Terry, Inc., of Clayton, New Jersey, reported that there had been no detectable metal pick-up from the Monel surfaces.

If you have a high-purity problem, here is a practical suggestion:

Write INCO's Corrosion Engineering Service, outlining the problem. They will be glad to suggest materials that will help you—either for immediate defense requirements or for future installations.

This all-Monel de-ionization unit, in service at Swansboro Ice Company, Swansboro, N. C., reduces the mineral content of well water from 250 ppm to 10 ppm, with flow of 500 gallons an hour. The entire unit is Monel, except the side tanks containing regenerating materials—yet after a full summer's operation, there had been no detectable metal pick-up, according to the fabricator, Hungerford & Terry, Inc., Clayton, N. J.

FOREMOST IN SERVICE

NICKEL (INCO) ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"®

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N.Y.

Sun Oil, Toledo, goes on stream with first big Houdriflow units...

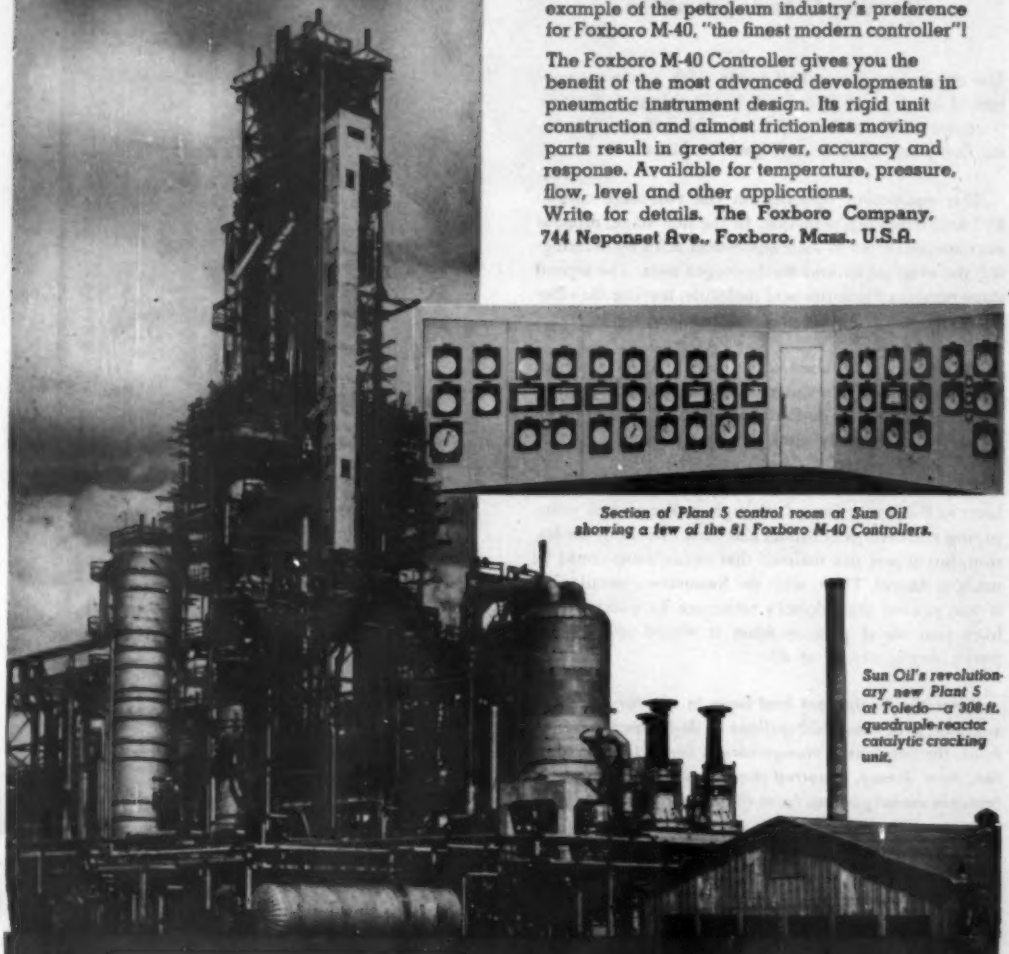
... under Foxboro M-40 Control

When Sun Oil Company's new Plant 5 at Toledo, Ohio, went on stream last May, 81 Model 40 Controllers took over critical control functions. Without any manual "juggling", process variables came directly to their control points, because M-40 met the preset values so exactly. And the inherent accuracy of the M-40 *held* them there, continuously!

This first major installation of Houdriflow "cat" crackers offers another outstanding example of the petroleum industry's preference for Foxboro M-40, "the finest modern controller"!

The Foxboro M-40 Controller gives you the benefit of the most advanced developments in pneumatic instrument design. Its rigid unit construction and almost frictionless moving parts result in greater power, accuracy and response. Available for temperature, pressure, flow, level and other applications. Write for details. **The Foxboro Company, 744 Neponset Ave., Foxboro, Mass., U.S.A.**

Section of Plant 5 control room at Sun Oil showing a few of the 81 Foxboro M-40 Controllers.



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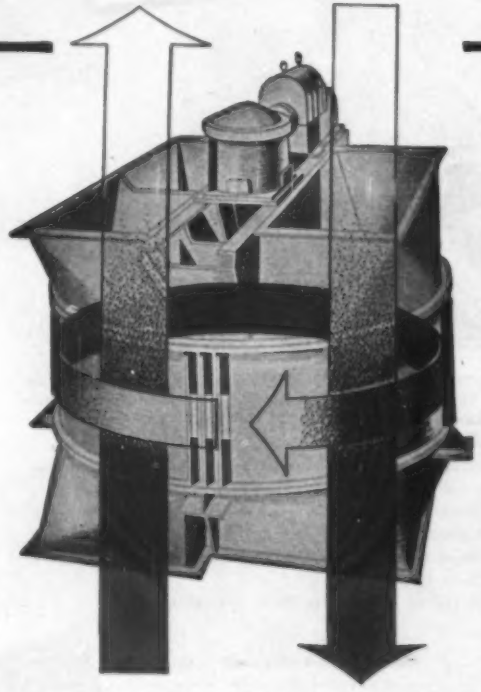
AIR PREHEATERS



Here indeed is impressive evidence of the wide acceptance of the Ljungstrom air preheater. Since the war the total capacity of steam generating units equipped with Ljungstrom air preheaters, installed, under construction or on order in industrial and utility plants throughout the country comes to well over 200,000,000 lbs of steam per hr.

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Fawley refinery *chooses . . .*

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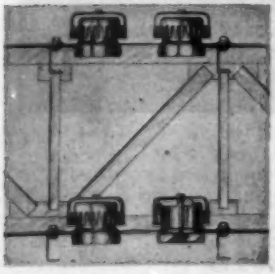

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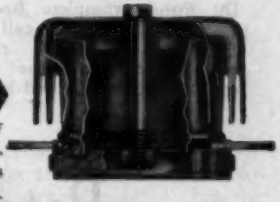

BUBBLE CAPS – new design permits quick, easy removal by one man working from top side. There are no flanges or projecting edges around holes to slow up cleaning operations.

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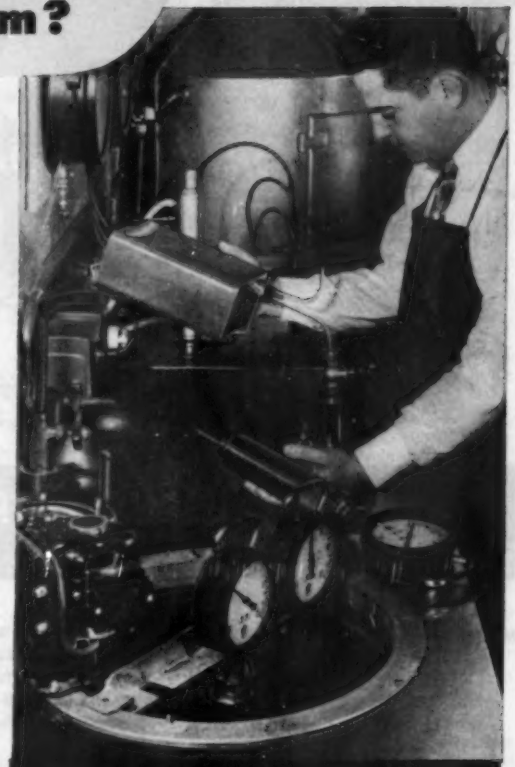

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PETROLEUM
REFINER
VOLUME 30, NO. 4 APRIL, 1951

The LOOK BOX

IN THIS issue of PETROLEUM REFINER a special section presents several articles of interest to gasoline plant men and others concerned with the processing of light hydrocarbons. The issue in no sense attempts a complete report of activities in this field. Rather, it is an assemblage of quite a bit of worthwhile material. Two articles deal with maintenance procedure and problems, two more with laboratory analysis matters, two with recently completed plants, one with gasoline plant treating practices, and one with low temperature processing methods applicable for small gas quantities.

It's a Special This Month

The gas processing industry, now 40-odd years of age, has achieved a considerable part of its truly remarkable growth within quite recent years. This is true in natural gasoline plants, in refinery vapor recovery and gas conversion units, and in petrochemical plants alike. Since the late thirties when high-pressure absorption and cycling plants were first built, there has been a rapid expansion of natural gas processing facilities. Conservation needs and a growing market for natural gas, light hydrocarbon liquid fuels, and gasolines, have resulted in plant construction to process most of the gas now produced in our gas and oil fields.

Effective processes have been adopted in the refineries to recover and convert gases, once wasted, into high-quality gasoline components. New petrochemical products have been developed and brought into production to supply an ever growing market. Synthetic rubbers, plastics, and a host of other hydrocarbon derived chemicals for an infinite number of uses are now made in volume commercial plants—and this industry is really just getting started.

The plans now on paper or projected as future possibilities seem to run on forever. They probably do. Active research is increasing our knowledge at a growing rate—and the results of this research materialize at an actually amazing rate. It is interesting to note that the recent annual report of E. I. duPont de Nemours & Company, pioneer in petrochemicals manufacture along with their other activities, listed some 460 million dollars of their 1950 sales, 35 percent, as production from facilities placed in operation since 1945.

Expansion A Weapon

A RAPID, planned expansion of the nation's basic productive might is America's "new and daring" weapon against the threat of war, according to Chester H. Lang, General Electric Company vice president. Speaking in New York recently, Lang declared that this deliberate, over-all growth is a brand new approach in the old game of power politics.

"It is not girding up for war," he said. "It is girding up for peace. As far as I know, no nation ever has tried it."

By avoiding the "normal historic reaction" of simply building a bigger army than the potential aggressor, the United States will achieve a balance of adequate armed strength while still maintaining itself as a "healthy, prosperous and peaceful nation."

Demands for complete mobilization of manpower and materials into a huge army are not smart. Rather, he said, the present military proposal seems much more sound. The first step is to build enough combat material to train and

Top-of-Page Photo—Propane and Butane Tank Battery, Products Storage Area, Plymouth Oil Company's Gas Processing Plant in the Benedum Field, Upton County, Texas. (Photo by Bill Thompson, Sinton, Texas.)

Are you making the most of BECKMAN pH METERS in your refining operations?

THE BECKMAN MODEL H-2 pH METER is one of a complete range of Beckman pH Meters available for every type of application*. The H-2 is particularly recommended for applications where high accuracy and simple operation—combined with the convenience and low cost of 115-v. AC operation—are desired.

It provides instant and direct pH readings, and a simple, built-in dial permits quick, convenient temperature compensation over the entire range of 0° to 100°C (32° to 212° F.). High reading accuracy is assured by wide-spread dual range scale that reads from 0 to 8 pH or from 6 to 14 pH at the turn of a switch. Same switch also provides instant millivolt readings from 0 to ±800 mv and from ±600 to ±1400 mv for titrations and oxidation-reduction measurements.

Built-in electrode support and compact case design save valuable space and permit easy portability to various plant locations.

Particularly important is the wide range of factory-sealed, maintenance-free Beckman Glass Electrodes available for use with this instrument . . . electrodes that are virtually unbreakable . . . that cover extreme temperature ranges from below freezing to above boiling . . . that have an unprecedented pH range with negligible errors . . . that are abrasion-resistant and chemically durable to a degree never before thought possible in glass electrodes.

*In addition to the H-2 Meter, other Beckman pH equipment includes completely automatic pH indication and control instruments for large-scale process applications . . . battery-operated models for complete portability in plant and field use . . . and a laboratory type instrument that features maximum versatility and accuracy for research and laboratory applications

Five ways to improve refinery operations with Beckman pH Control

Leading refineries are using Beckman pH Control for many profitable applications that save time and money, reduce maintenance and increase plant efficiency. Whether yours is a small or large refinery, we suggest that you investigate the savings to be made by such typical applications as these . . .

1. **NEUTRALIZING CRUDE STOCK ACIDITIES** *to prevent damage and corrosion to costly equipment.*
2. **MAINTAINING CONSTANT COOLING WATER CHECK** *for immediate detection of hidden leaks in lines and equipment.*
3. **NEUTRALIZING ACIDS IN STILLS** *to assure a uniform acid-free product.*
4. **TREATING PROCESS AND BOILER FEED WATER** *to assure soft, neutral water, greater freedom from liming and boiler maintenance, and substantial savings in chemicals.*
5. **RELIABLE CONTROL OF WASTE DISPOSAL** *with better neutralization of acid and caustic effluents . . . at lower chemical costs.*

These are only typical of the many money-saving ways modern refineries are using Beckman pH Control. See your nearest authorized Beckman dealer for more details on these and other refinery applications—or write direct.

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BECKMAN INSTRUMENTS
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equip a force for the first year of a possible war. The second step is to build our productive capacity to carry on from there.

According to present plans, Lang estimated, the nation's annual defense spending will reach a peak of 65 billion dollars in 1952. This expenditure will amount to only about 20 percent of the national output, leaving 80 percent for civilian needs. This is at sharp contrast with the World War II economy when war spending rose to 42 percent of the national effort.

"America is trying something new and daring in this old game of power politics. Where the normal historic reaction is simply to build a bigger army . . . America has undertaken a much more imaginative task: She will deliberately grow!"

Private industry, Lang emphasized, will do 90 percent of the job, with an outlay of nearly 70 billion dollars for expansion and improvement planned during the next three years alone. Production, arming brave men willing to fight, is America's key to survival against Communism. "We can't outnumber them, we can't outslave them. But we can outproduce them."

Industry Growth Spectacular

CONTINUED spectacular growth of the oil industry, reaching as much as 47 percent in the decade of 1950-1960, is predicted by H. S. M. Burns, president of Shell Oil Company. In a talk made before the New York Society of Security Analysts, he pointed out that the increase in demand for petroleum products in 1950 was the highest since the end of the war, and foresaw that domestic consumption would go up to between 6.9 million and 7.1 million barrels per day in 1951.

Necessary production to meet this demand seems assured, Mr. Burns stated, "as long as the oil industry enjoys freedom in its search for oil and freedom in its competition with itself and with other sources of energy." Oil alone now supplies approximately 40 percent of the nation's domestic energy requirements, and natural gas another 16.8 percent.

Mr. Burns commented that Shell's refinery intakes, since 1947, have increased 21.6 percent compared with 12.7 percent for the industry at large. The company's refining capacity will be further increased at its Wood River, Ill., refinery, and an expansion of both crude and product pipe line systems is contemplated, provided the necessary steel can be obtained.

Sales in 1950 of Shell Chemical Corporation, a subsidiary, were 38 percent above the previous year, Mr. Burns declared. A 50-percent expansion in synthetic glycerine production and additional facilities for manufacture of ammonia are now under way.

Suggestions Plan Paying Off

SOCONY-VACUUM Oil Company, Inc., reports that an average of 17 suggestions for improving the firm's operations was received last year from each 100 employees. Of these suggestions, 21.6 percent were recognized with cash awards amounting to over $27,000.

Proportionate to the number of employes, the company's refinery at Paulsboro, N. J., yielded a greater number of suggestions than any other unit with an average of 41 per 100.

Socony-Vacuum instituted its suggestions system in 1948. Many of the accepted ideas receive additional awards when they are adopted by other refineries or marketing divisions than the ones in which they originate. All ideas are circulated monthly in an "Idea Exchange" distributed to all Socony-Vacuum units.

Oil Industry's Good Record

STILL supplying fully all the existing military and civilian needs for its products, in spite of the tremendous size of the job, the petroleum industry in this abnormal and critical time should command the full respect and confidence of the American people. On its record, the industry should help to give the people faith also in the ability of American free, competitive enterprise in general to meet whatever problems may arise.

Realizing that its foremost duty was to remain able to provide all the oils that might be needed, the industry planned and acted boldly and confidently, pouring $2 billion a year, for five years, 1946-1950, into new wells, pipe lines, refineries, tankers, storage tanks, and other facilities, a total of more than $10 billion invested in the five years. This was done although it required plowing-back of relatively high proportions of earnings and relatively low dividends available for payment to stockholders. The industry also will continue to spend more than $2 billion annually for additional facilities for some time to come if materials and supplies are available.

The industry needs to publicize its record of able service to the people, especially when confronted with threats of government action that would impair or destroy its effectiveness.

It is the industry's obligation also to advise the public that oil has been made plentiful and cheap in the U. S. through freedom of action by competitors always trying to outdo and undersell each other—not through government planning or controls. It is the industry's duty to warn the people that oil will not long be either plentiful or cheap under controls and restrictions, such as price and wage controls, that prevent freedom of action and competition and destroy initiative.

Preventive Maintenance For Engines and Compressors

ROBERT S. RIDGWAY
Standard Oil Company of California, Whittier, Calif.

THE PRACTICE of preventive maintenance for gas engines and compressors is based on establishing periods of operating time considered safe between overhauls. Benefits possible under such a program include reduced maintenance cost, better performance factors for equipment at higher operating efficiencies, and performance of maintenance work with small repair crews.

Maintenance cost and operating cost are both of interest to plant management. Together they determine overall plant efficiency. While both are considered in the initial design of the plant, operating cost becomes more or less fixed by design. Maintenance cost, however, if permitted, can assume staggering proportions. On the other hand, an adequate program of preventive maintenance carefully followed will usually assure low costs. Maintenance tends then to become simply another factor in plant operation.

EVER since the days of the old steam engine, there have been those who believed that machinery should operate only while it was in good operating condition, and that it should be dismantled and reconditioned before any of the parts became excessively worn. These people were firm in their belief that this practice resulted in better over-all economies than operating the machine until it failed to perform properly; so they established a period of time which they considered a safe run between overhauls.

And thus was born the practice of preventive maintenance. This practice has been carried on with increasing momentum through the days of old slow-speed gas engine equipment and is commonplace in the life of our modern angle compressor units, both on the engine and the compressor ends. Yet despite this growing practice, there are a group of operators who believe that they come out ahead by watching their equipment by means of all the external signs, and overhauling when any of the signs indicate that work is necessary.

Under such a procedure, it is possible that no two units which may be identical will run for the same time interval. These people would be the first to point out that even the average engineer does not have the motor in his personal car taken down and overhauled at 50,000 miles just because it has run 50,000 miles, if his oil consumption has not increased, or if he is getting full power, maximum speed and quiet operation. Yet another man with the identical make and model car may have had to overhaul at 40,000 miles because of relatively poor performance. So it can be seen that the subject is a controversial one.

TABLE 1
Maintenance Schedule—1951

UNIT	VALVES		PULL PISTONS		KEY BEARINGS		COMPRESSOR				
								VALVES		RINGS & BEARINGS	
	Last	Next	Last	Next	Last	Next	Cyl. Size	Last	Next	Last	Next
1	2-20-50	2- 5-51	2- 7-49	2- 5-51	9-11-50	3-12-51	1 9½ 2 9¾ 3 6 4 6	9-11-50 9-11-50 9-11-50 9-11-50	9-10-51 9-10-51 3-12-51 3-12-51	3-14-49 3-14-49 9-12-49 9-12-49	3-12-51 3-12-51 9-10-51 9-10-51
2	11- 4-50	11- 5-51	11- 4-50	11- 6-52	10- 9-50	4-11-51	1 9½ 2 6 3 — 4 3½	4-24-50 10- 9-50	4-11-51 4-11-51 — 4-11-51	4- 4-49 4-11-51 — 4- 3-50	4-11-51 4-11-51 — 4-11-51
3	2-13-50	2- 7-51	2-13-50	2-11-52	9- 5-50	3- 5-51	1 9½ 2 9¾ 3 6 4 6	9- 5-50 9- 5-50 9- 6-50 9- 6-50	9- 4-51 9- 4-51 3- 5-51 3- 5-51	9- 6-49 9- 6-49 9- 6-50 9- 6-50	9- 4-51 9- 4-51 9- 8-52 9- 8-52
4	1- 8-50	1- 8-51	1-13-49	1- 8-51	11-16-50	5-14-51	1 9½ 2 6 3 — 4 3½	11-15-50 11-17-50 — 11-16-50	11-12-51 5-14-51 — 5-14-51	11-15-50 11-17-50 — 5-25-50	11-17-52 11-17-52 — 5-14-51

Typical maintenance schedule for major repair work performed by maintenance crew for a 4-unit booster plant with 4-cycle gas engine-driven compressors. Column headings note only the major operation. For example, work under "pull pistons" includes taking piston and cylinder measurements, cleaning pistons, cleaning or renewing rings, checking camshaft, cam shaft bearings and drive chain, checking water pump chain, governor, upper and lower power pins, oil pump, oil lines, cleaning oil cooler and crankcase. The plant crew are responsible for periodic cleaning of mixing box, lubricator, magneto exchange for service, and other minor operations.

The Case for Preventive Maintenance

And so it is in order to review the case for preventive maintenance. Why do we do it? Why are we not content to observe the external signs and work on our engine and compressor units when these signs dictate, as most of us deal with maintenance on our own automobiles? In my opinion, the proponents of preventive maintenance have three major reasons for such a program: 1) To reduce maintenance expense, 2) to provide better performance factors for their equipment at higher operating efficiencies, and 3) to cover the maintenance work with a smaller repair crew.

To examine these three reasons in more detail:

1) Reducing Maintenance Expense.

Those advocating preventive maintenance would say that with heavy-duty gas engines, the removal of power pistons for periodic cleanup of rings and pistons is essential to provide minimum cylinder wall wear, to prevent scuffing and galling, and to eliminate the possibility of piston seizure with attendant spoilage of cylinder and piston. These people will argue that the insurance of somewhat more frequent cleanup will be more than offset by the occasional damage to such equipment caused by operating it too long. On four-cycle exhaust valves and seats, they would feel that the reconditioning of these parts before they have burned and destroyed themselves will be well justified by the much longer service life of the equipment.

Further, a bad valve or seat unbalances the whole engine, throwing over-

REPAIR DATA NG-6

Plant | Engine Comp. No. | Frame No. | Date | Order No.

CYLINDER | MICROMETER READINGS | By

Group No.	Position	No. 1 Throw Position	Head End (No. 2)		Center (No. 2)		Crank End (No. 6)		Piston Sizes Crank End	
		C.W. (Top)	C.S.W. (Side)	C.W.	C.S.W.	C.W.	C.S.W.	C.W.	C.S.W.	C.W.	C.S.W.
	1 OR 2 OR L										
	2 OR 3 OR R										
	5 OR 7										
	4 OR 8										

Throw and Timing

PISTON RING RECORD

Cyl.	Grp. No.	Rings On: New Used	Size or Size No.	Ring Clear	Ring Gap	Kind of Rings	Rings Off: Condition	Cyl.	Grp. No.	Rings On: New Used	Size or Size No.	Ring Clear	Ring Gap	Kind of Rings	Rings Off: Condition
1 OR 2 OR L	1							5 OR 7	1						
	2								2						
	3								3						
	4								4						
	5								5						
	6								6						
	7								7						
3 OR 4 OR R	1							4 OR 8	1						
	2								2						
	3								3						
	4								4						
	5								5						
	6								6						
	7								7						

COMPRESSOR RING GROOVE DIMENSIONS

Depth | Width | Min.

BEARING RECORD

Location	Pin Size	Grey	Key	Amt. of Take Up	Condition	Location	Shaft Size	Grey	Key	Amt. of Take Up	Condition
1 OR L. CR.						1 OR L. MAIN					
2 OR 3 CR.						2 OR C. MAIN					
" R. CR.						3 OR R. MAIN					
4 CR.						4 MAIN					
1 OR L. W. PIN OR E. NO.						5 MAIN					
2 OR 3 W. PIN OR C. NO.						PROPELLER					
3 W. PIN OR R. NO.											
4 W. PIN OR E. NO.											

Washers Jackbolts or Comp. | End | Crankshaft Oil Gap | End | Comp. | Vol. Liners | New | Old

(Give data on valves, seats, and guides—kind, whether replaced or refaced, condition, etc.)

Foreman

Figure 2. Typical Repair Data Sheet, filled out by Gang Foreman during overhaul. One copy becomes part of plant records, duplicate is retained by Maintenance Division.

load on other cylinders, which foreshortens the whole running period of the engine and occasionally causes damage. Two-cycle injection valves and two-cycle scavenging valve feathers follow in a somewhat similar category, the theory being that trueing up after slight wear is cheaper than the possibility of having to discard the complete valve or seat because of uneven wear. The same type of reasoning applies to bearings, where proper adjustment is justified over bearing breakage due to running too long. For the compressor, the justification of periodic overhaul is that of replacing rings, refacing valves and seats, and reconditioning metal packing at a point where it can be reconditioned for further use, and so extending its useful life.

2) Giving Better Performance Factors and Higher Efficiency.

This perhaps is the strongest of the arguments advanced by the proponents of preventive maintenance. Their reasoning is that, with scheduled overhauls occurring prior to the time the machine suffers from impaired output, there is always sufficient horsepower to carry the load; hence, no shutdowns occurring from overloading at inopportune times to cause loss of production. Nor are there forced shutdowns due to valve, seat, bearing or other failures because the units have run too long. Such forced shutdowns so frequently occur at night or on weekends when the delay of getting the maintenance crew to work can cause expensive production losses.

Preventive maintenance, then, is claimed to keep the machine on the line a higher percentage of time, and with better output. The difference between the performance together with the other gains, must be sufficient to justify the procedure. As well as keeping the unit on the line a higher percentage of the time, the fuel economy should be better. When it is considered that a 10 percent decrease in fuel economy on a 600-hp. engine is worth approximately $75 per month in fuel alone, it does not take long at this rate to pay for a "cleanup" and reconditioning of valves on such an engine. Faulty valves and rings on compressors can and frequently do cause losses of a much greater magnitude than this, for it must be remembered that the majority of "slippages" past compressor rings and valves demand just as much output from the prime mover as though the compressor were handling its rated volume of gas. Losses at this point are expensive, either in the capacity loss which is reflected in production, or in the unnecessary operation of standby equipment, as the case may be, to fulfill requirements of the field. It is also expensive from the standpoint of fuel economy due to excess horsepower requirements of improperly operating cylinders. These items are cumulative, and proponents of preventive maintenance probably find an easier payout in the case of the compressor than for any other equipment. When it is considered that compressor overhaul work usually comes easier and a little cheaper in most cases than gas engine work, the case becomes still stronger for this type of handling.

3) Maintenance Work for a Given Territory by a Smaller Maintenance Crew.

Of course, basically this argument would group itself also under Item 1 —that of reducing maintenance expense. But it has been the frequent claim of operators whose territory covered a certain number of compressor plants, that their maintenance crew was cut down to a bare minimum only because they scheduled the complete maintenance operations on a preventive basis over the year, leaving a minimum of "free' days for the unexpected. Under such a system, they knew just what to expect in the way of engine conditions when they opened them and knew just how long it

Figure 3. Excessive carbon buildup behind piston ring.

Figure 4. Water-Cooled Exhaust Valve Head from which Stem has been cut, and Mating Seat (right) Showing Excessive Wear. Also Very Unusual Type of Wear Due to Hard Metal in a Section of Seat. Cast iron exhaust valve seat (left) from another engine shows typical excessive wear.

would take them to complete their work. They caught all the repair work when they wanted to do it, and not when the engine chose to be worked on. Consequently, they were not continually running into conditions where, for a time, they fumbled around looking for work then found themselves snowed under by the problem of having several units "down for repairs" at the same time, and the crew too small to do the repair work in the time required. Most of us have faced this latter situation occasionally; and it is at such times when some program of preventive maintenance looks most attractive to us. Such scheduling can also provide for vacation periods for the maintenance crew and presents less likelihood of disruption when vacations are being taken. It is customary in areas of extreme summer temperatures, like the San Joaquin Valley, for schedules to be worked up which will provide for routine overhaul at times other than the summer season. Such practice is well appreciated by any maintenance crew.

Scheduling Preventive Maintenance

How long should be intervals which are set for the periods of overhaul and how are they determined? Are they inflexible or should they be changed from time to time? If they should be changed, what are the factors which affect such changes? Should the intervals be the same for all makes of engines or can they vary between make and model? Does the load affect the period? These are some of the questions which arise when such a program is initiated.

The intervals in such a program are subject to constant scrutiny, for, though it is our aim to do the overhaul work as frequent as is necessary to keep ahead of the onset of wear which would either cause damage to running parts, loss of parts due to inability to recondition them, or impaired efficiency or operation of the machine, it is our economic aim not to do any work more frequently than is required to fulfill the requirements of the foregoing. Therefore, the best time schedules will be set by the keenest observers. (Figures 1 and 2.)

In the cylinder and combustion chamber group, the four-cycle machine will focus attention on the valves. Tendency to wear, particularly when wear is uneven, will cause burning of valves or seats or both. Servicing periods must be sufficiently frequent to prevent such an occurrence. This leads at once to the thought that if the quality of material were to be improved, or the design, or the lubrication, perhaps the service interval could be extended. And so we see that the service interval can probably be flexed again and again as improvements are effected.

The performance of the piston and rings in both two and four-cycle machines is doubtless a function of the design of the components and the lubricant used, as the carbon formed on the piston and rings will probably be the critical factor which determines the time of "cleanup". When rings are stuck, we look to the ring groove clearance, operating temperature in the particular design involved, and the lubricating oil for sources of possible improvement in operating periods. We study the amount and location of the carbon deposits to determine whether or not the piston has operated over too long a period. When rings are stuck, they are always fixed in a position against the cylinder wall, and when the ring becomes locked so tightly to the piston that it cannot be forced down into the groove, then all that is necessary to cause abnormal cylinder wear, scuffing, or even scoring, is for that piston to become overheated or just heated to a point somewhat higher than it was when the ring froze in the groove. It is like making a section of the piston of such a diameter that there is no running clearance at some operating temperature. Any increase in temperature of the piston, then, results in negative clearance.

Quite a sinister occurrence, and one which must be quite carefully watched, is the formation of carbon behind rings or between the rings and the groove. The carbon "build up" at this point can and does occur, resulting in the inability of the ring to be forced down in the groove. When all of the clearance space has been filled up with carbon, the piston has only to become somewhat warmer due to change in load or distribution of load between cylinders, to cause trouble. The occurrence of carbon behind rings is tricky because, if one were not watching for it, he might be led to believe that the carbon condition on the piston was acceptable because all of the rings were free, where on further investigation, the top two ring grooves might be found to be completely blocked up with carbon to the danger point. (Figure 3.)

So, with these criteria, the running period for servicing four-cycle valves, and for cleanup of pistons and rings can be set. Fortunate indeed, is the maintenance man who finds that the periods rather closely coincide. In one particular make and type of four-cycle engine which we operate, we are finding that the required valve servicing period has been causing us to cleanup our pistons more often than necessary, and that we can come out ahead by having two valve servicing jobs to one piston cleanup. This becomes more interesting when it is considered that the more frequent valve servicing job keeps the load balance between cylinders more even, thus giving freedom from abnormal piston temperatures which makes the longer piston cleanup interval more secure and certain (Figure 4).

On the two-cycle engine, the injection valve condition can be watched readily, due to the ease with which they are changed. As the heads do not have to be removed to effect this change, this item should really not be included in the combustion chamber group, noted above for the four-cycle engine. Rather, change of these valves should be made when adjustment of other equipment, and readjustment for proper operating conditions fails to produce the required load balance between power cylinders (Figure 5).

On two-cycle units, overhaul periods in the combustion chamber group can be extended by maintaining proper load balance between power cylinders. Provision for this is provided for by most manufacturers of modern two-cycle engines in providing a pyrometer with thermocouples close to the

exhaust ports. But there is considerable controversy on the point of whether or not an even exhaust temperature balance reflects an equal load balance between cylinders. Certainly, this temperature is a significant factor in operation, and one which we should be able to see at all times. But we have observed cases of uneven load balance with relatively even exhaust temperatures, and are inclined to feel that indicator analyses are essential to provide best balance. Due to the costliness of indicator apparatus, such balance is usually one taken with pressure only, assuming that the maximum explosion pressure will be in proportion to the mean effective pressure.

Operators of gas engines have long awaited a simple and inexpensive indicator motion by means of which they can make load balance checks and thus extend their overhaul periods by preventing overloaded cylinders. Load balance on two-cycle engines becomes upset from a number of causes, chief of which are (a) reduction of scavenging pressure, (b) improper adjustment or wear on injection valves, or (c) carbon formation on ports or in inlet or exhaust passages (Figure 6). Scavenging pressure should be observed when the engine is first balanced, the air cleaner is known to be clean; the scavenging valves known to be in good shape; the passages and ports clean; and the air dampers, if any, are set for proper balance. An indicating gage or manometer (Figure 7) should be installed so that operators may watch this pressure, and the cause of any deviations therefrom should be promptly ascertained. If the scavenging valves and air cleaner are in proper shape, the deviation of scavenging pressure will probably be caused by carbon on ports and passages, and this should be taken care of before any appreciable scavenging pressure change occurs, in order to preserve load balance.

Some operators work from this scavenging pressure to determine when to clean. Others work from a strictly time basis, based on observation. But, at any rate, the point to be stressed is that variation of scavenging pressure usually indicates a condition which will cause unbalance of load between cylinders. Therefore, it follows that the preventive maintenance required to preserve an even scavenging pressure will also contribute to extending the runs obtained from the cylinder group because of the fact that load balance between power cylinders is improved.

Intervals between bearing adjustment, where load and oil temperatures are relatively constant, are normally strictly a time function, and can usually be scheduled as some multiple of the main engine cleanup. Bearings on the large gas engine-driven compressors are usually taken up once or even several times between engine "cleanup".

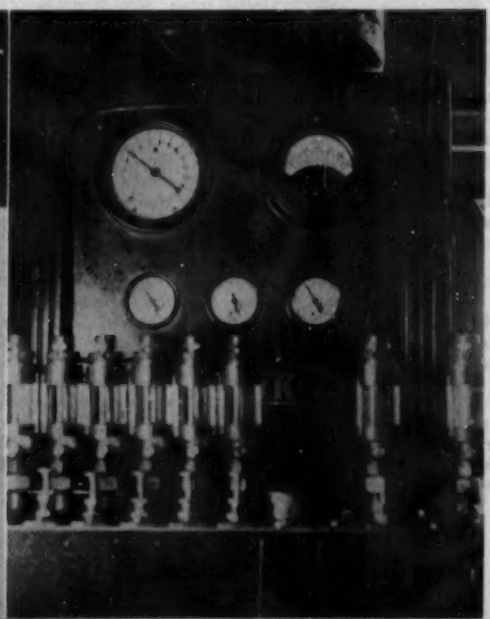
Compressor valves and rings require attention at time intervals which vary widely from numerous causes. High pressure, wet gases and corrosive gases presenting conditions which require much more frequent attention. Observations will dictate a proper time interval for attention, and it is unlikely that the proper period for ring replacement will coincide with the proper period for valve servicing. It is much more probable that the interval between compressor valve servicing may coincide with that required for bearing take-up.

Having thus worked up the proper interval between servicing periods which is sufficiently frequent to prevent excessive wear, cause unforseen shutdowns, fit the schedules for the maintenance crew, yet be practical and workable, it is not wise to assume that we can coast along with such schedules. It should be our problem, instead, to attempt to better the performance of rings, pistons, valves, seats, bearings, and other parts by improvements in design, study of tolerances and clearances, improvements in metals and materials, the adoption of better lubricants for the specific duty involved, studies to determine optimum temperatures and cooling rates and so on, so that we can keep extending the time intervals without increasing our insurance risk.

Although there are many operators who perform their maintenance work according to schedules as outlined above, there are still a number who are either not sold on the idea, or who accept it only to a limited extent. They present an interesting case for no preventive maintenance. In the first place, they make the sound and justifiable claim that if they can determine when an particular machine is in need of overhaul, and if this time can be determined without having run too long

Figure 5. Wear on Injection Valve and Seat.

Figure 7. Gage Installation on Instrument Panel of Two-Cycle Engine to Show Scavenging Pressure.



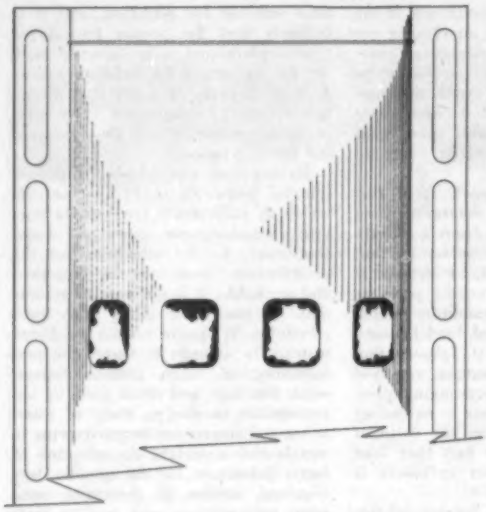
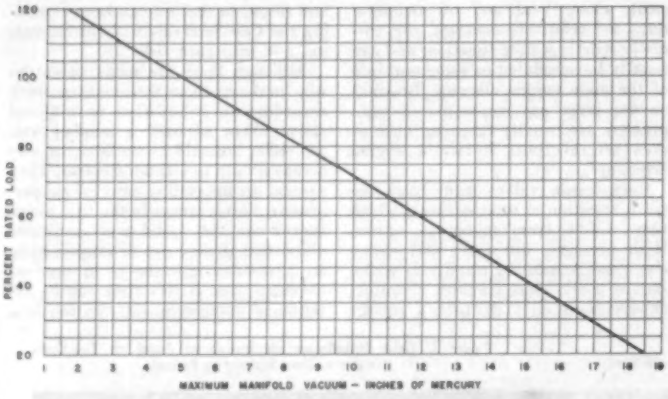


Figure 6. Carbon on Intake Ports. Two-Cycle Gas Engine Cylinder Showing Harmful Carbon Accumulation on Inlet Ports.



Below
Figure 8. Manifold Depression Curve. Typical curve for four-cycle engine showing manifold vacuum which should be attained at mix for maximum power when operating at rated speed and 30 inches Barometer.

or caused any damage or contributed to excess wear, then fewer overhauls will be done in a given period than with a set time schedule, for the overhaul schedules in any program of preventive maintenance are based on the shortest time interval to prevent trouble, therefore most of the machines will run well in excess of this minimum time. This reasoning is valid. The point in question is whether or not one can determine from operating data, tests, and exterior observations when the overhaul work should be done.

Naturally, the contention of those who feel such control of overhaul to be satisfactory, is that they *can* make the determinations in this manner. Valve, seat, and ring conditions in four-cycle engines can be checked by careful observation of manifold depression, correlated with load and speed (Figure 8). For some conditions of valve and seat trouble, the manifold gauge will serve as a detector (Figure 9). Checks on the position of the valve stem will frequently indicate when excessive seat wear is being encountered, resulting in reduced volumetric efficiency and power output on the cylinder in question. The engine indicator will usually show this condition on slow speed engines (Figure 10). Excessive blow-by of piston rings can frequently be observed.

Pressure drop through the air cleaner and intake system should be observed on a permanently installed manometer, used for this purpose (Figure 11). We have noted before that scavenging systems on all two-cycle engines should be equipped with permanent gauges or manometers for instant reference. This is another essential control point in indicating the condition of the scavenging system.

The most difficult thing to determine from external tests is the condition of the piston rings. Some operators of two-cycle engines feel that they can tell sufficiently well by removing the inspection cover and looking through the exhaust ports. Unless the condition of piston and rings appears exceptionally clean and free, we are of the opinion that such observations are apt to be misleading. It is sometimes possible to determine if rings are blowing by, or are faulty, or broken, by taking full indicator cards. This is a practical method in double-acting engines, (Figure 12) but it is normally not too practical in the case of the vertical engine, and when used, if it shows that the rings are faulty, in all probability the run will have been carried too far. A "cleanup" should have been made earlier for the sake of the carbon.

In certain engines, crankcase oil consumption will indicate ring condition. Aside from this, there seems to be no way to know how much carbon has built up behind the rings or how many rings are stuck, unless we pull the pistons and examine them. This is the prime obstacle in the path of the operator attempting to govern maintenance from tests and external observations.

This situation must be dealt with in one of two ways. Either the operator must set a time interval for pulling pistons and cleaning them, or he must run until his tests or lack of engine power indicate that rings are faulty, and discount any excessive wear rate which may be due to carbon formation. This carbon condition, of course, will not be alike for different makes and models of engines, and certainly not for different lubricants. And, with certain combinations of engines, lubricants, loads, and operating temperatures, the carbon condition may not be a factor in excessive wear at all, up to the point where ring replacement is indicated.

On the compressor end of the machine, the external tests are perhaps a little more pointed in their indication of trouble. Loss of metered throughput indicates troubles somewhere. It is usually possible by shutting off machines one by one to locate just which machine is responsible. It is frequently possible to segregate ring and valve trouble (Figures 13 and 14), particularly if an indicator is used. However, most operators are not interested in such a segregation, as they find it easier to look at both rings and valves after the faulty cylinder has been located.

Carbon deposits on compressor discharge valves and passages are occa-

sionally a source of extreme hazard as the restriction which is created causes excessive pressures within compressor cylinders (Figure 15). Safety valves are normally located downstream from such restrictions and therefore cannot protect the cylinders against such pressures. The maintenance interval for this area should be such as to preclude such a restriction. Packing will usually very forcefully and effectively call attention to the fact that it is not operating properly.

Operators who thus watch their equipment and overhaul when the signs and tests indicate that overhaul is necessary can and frequently do come up with low maintenance costs. It is somewhat easier to operate this way in plants where there are spare units, and where the load is not excessive. In such instances, delay in repair will cause no loss of production, and with the ability to spread the work over a longer period, a limited size maintenance crew can often keep up with their work.

The proponents of preventive maintenance may be more likely to grant that equipment which is lightly loaded and in plants where there are spare units, coupled with highly experienced operators, may be maintained in an economical manner from tests and external observations. For large scale operation, however, they would claim the reasoning set forth in the earlier part of this paper would be sufficient to justify a preventive maintenance schedule, and that any other method of controlling maintenance would be too cumbersome to handle, and that the dangers which could result in cumulative trouble would make any other type of maintenance too costly.

Perhaps it would be well to see how some of our local people handle their maintenance problems. Every type of practice is prevalent in California, from complete preventive maintenance to none whatever. The majority of operators contacted, however, are operating on a definite time schedule for maintenance, particularly on the newer type units. The reports of most operators indicate that they are convinced of the necessity of performing maintenance at definite time intervals, but are not yet prepared to be too definite about the interval. Perhaps in another few years we will feel much more certain about the period involved; although, as pointed out, improvement in design, materials, lubricants, and operating practices should permit an extension of the periods if we are able to meet the challenge.

In our own organization, we have a rather wide difference in maintenance practices; the reasons being dictated by conditions within the various districts. For example, in one district, where operations are spread over a wide territory, plants being as remote as 40 miles from headquarters, and all plants being serviced by the same maintenance crew, a rather strict program of preventive maintenance is followed on all units, old or modern. The district feels that by so handling their

Figure 10. Worn Valve Seat Card. Weak Spring Card from Four-Cycle Power Clyinder Showing Worn Valve Seat.

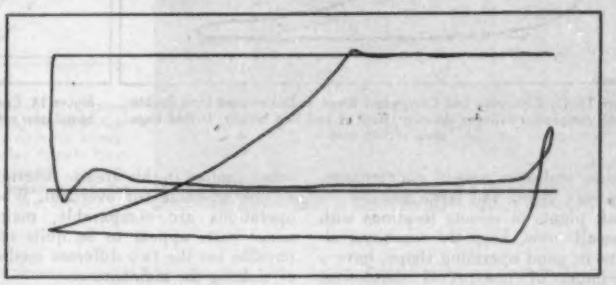


Figure 9. Manometer Installation on Four-Cycle Engine to Show Manifold Depression.

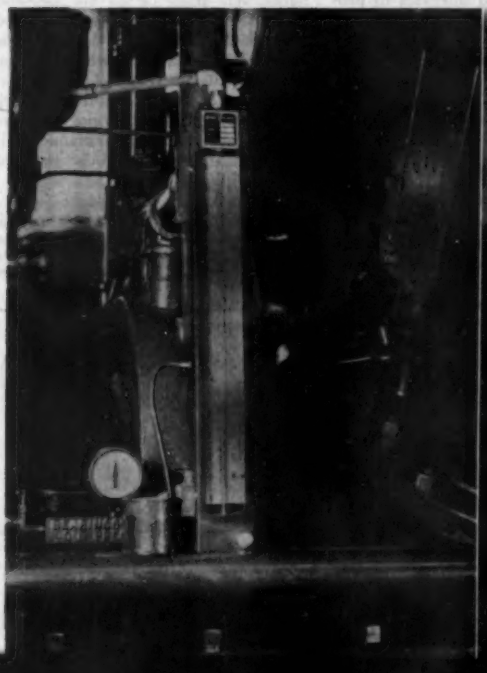
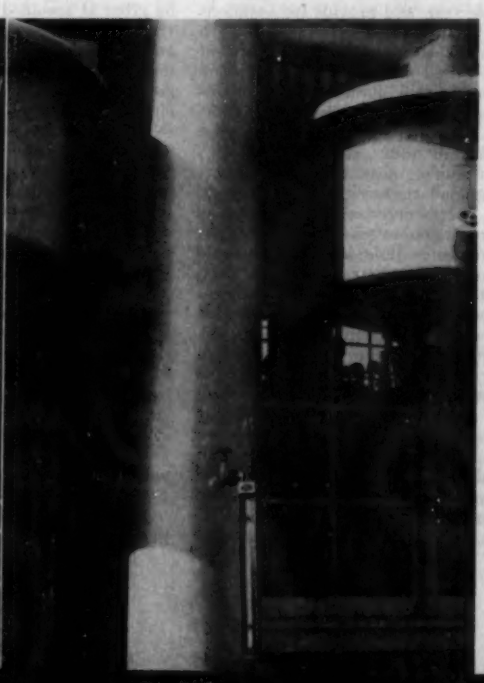


Figure 11. Manometer installation between air cleaner and scavenging cylinder on two-cycle engine to show pressure drop through air cleaner.



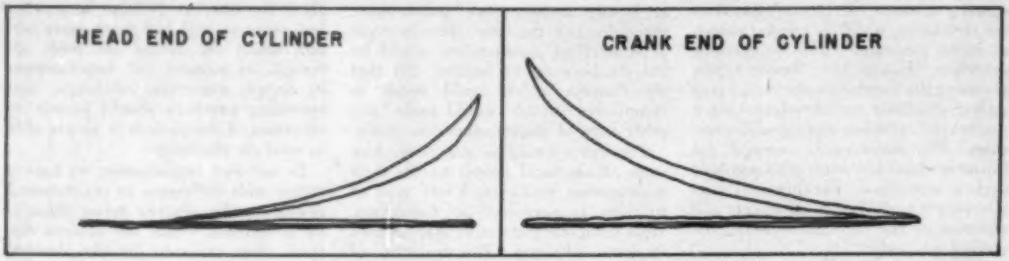


Figure 12. Compression cards on double acting engine. Compression cards from opposite ends of double acting four-cycle cylinder showing head end blowing through to crank end and consequent difference in compression pressure. Cards taken under load. Ignition turned off for one revolution.

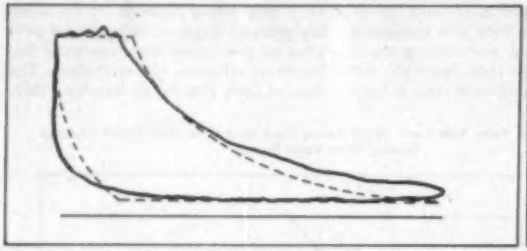


Figure 13. Card Showing Bad Compressor Rings. Indicator card from double acting compressor cylinder showing effect of bad ring blowby. Dotted lines show perfect card.

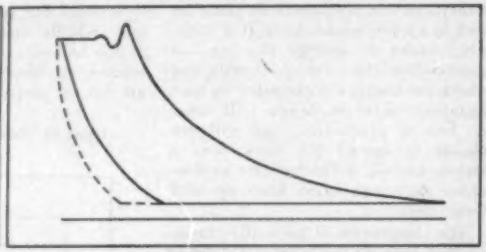


Figure 14. Card Showing Bad Compressor Rings. Indicator card from compressor cylinder showing effect of leaking discharge valve. Dotted lines show perfect card.

engine and compressor maintenance, they can cover the large number of small plants in remote locations with a small crew, keep the machines always in good operating shape, have a minimum of unexpected shutdowns, closely anticipate the amount of work to be expected when overhauls are made, be able to schedule the heavy work in the more comfortable seasons of the year, and provide for vacations and vacation relief in the summer. The situation sounds rather Utopian, of course, and we must expect some situations to turn up which tend to discolor the complete rosiness of the picture. However, in general, the plan works out quite satisfactorily.

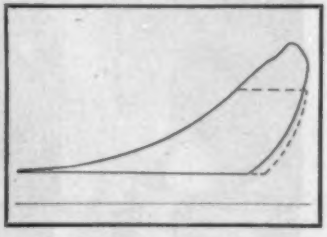
In another district where loads are heavy and spare units are the exception, the modern units are maintained under a rather complete preventive maintenance time schedule. The old style horizontal machines are overhauled when they begin to show signs of weakness. In this particular district, the old style machines are in the minority; hence, they influence results but little. In a third area where old style gas engines are the rule, loads are normally below full and spare units are available, no particular schedule of preventive maintenance is practiced on the old units. They are rather closely observed, and overhauled when external tests and observations indicate a necessity. The modern units are being studied in this area to determine a time schedule for overhaul. Where operations are comparable, maintenance costs appear to be quite comparable for the two different methods of treating the maintenance.

As to the recommendations of manufacturers, we find that the four contacted are all in agreement that complete and thorough inspection should be given at specified intervals to provide a cleanup and permit adjustment and replacement of parts. Most of these people make a definite recommendation for pulling pistons and cleaning carbon at 12-month intervals.

All of the foregoing indicates that it is difficult and dangerous to lay down hard and fast rules for maintenance which will make a blanket coverage of the maintenance for all styles and types of gas engines and compressors, regardless of load, availability of spare units, size of crew, dispersion of the plants serviced by the same crew, and so on. The particular circumstances involved, coupled with the ability of the operators to recognize the significant signs will alter the situation to the extent that widely different practices may be adopted in different areas, yet either practice may result in the lowest over-all cost of maintenance under the combination of prevailing circumstances.

Although an effort has been made to present the case both for and against preventive maintenance, it is our feeling that the conditions under which no preventive maintenance may be justified are limited and represent only a rather small proportion of gas engine and compressor operations today. Although it is a great credit to those who are able to make such a practice work out satisfactorily, it is treading on dangerous ground. The maintenance man must be on his toes continually if he operates without schedules. It is our opinion that the most satisfactory condition will result from the use of preventive maintenance schedules for most of the repair operations, using all our skill and operating ability to do those things which will steadily extend the periods and thus improve the system.

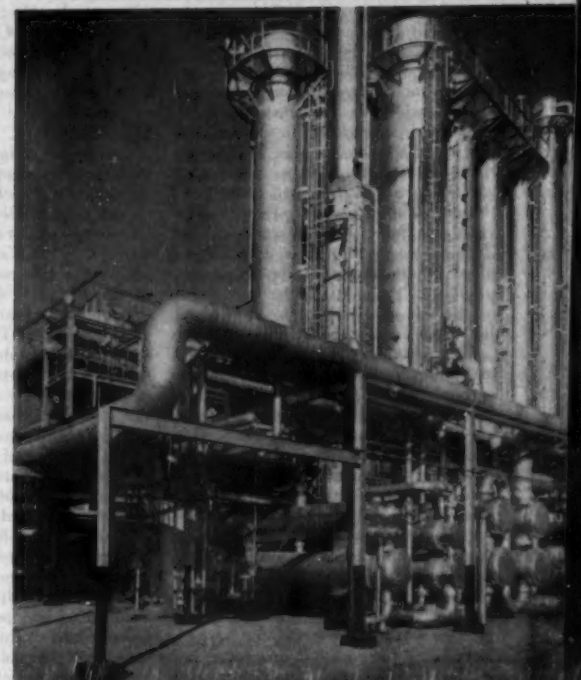
Figure 15. Card Showing Carbon Deposits. Indicator card from compressor cylinder showing effect of carbon deposits on discharge valves and passages. Dotted lines show perfect card.



Panoma Plant Achieves Low Maintenance-Operation Costs

Part I

I. EARL NUTTER and C. D. VAN VLIET
Panoma Corporation, Amarillo, Texas



Closeup of Process Area, Panoma Corporation's Hooker, Okla., Plant. Heat exchangers and instrument details may be noted.

THE natural gasoline plant, near Hooker, in Texas County, Oklahoma, owned and operated by Panoma Corporation, has been operating at design conditions since it was placed on stream. Design of the plant included consideration of operating and maintenance costs, as well as process efficiency, as prime objectives. As a result, performance records of the plant have been excellent. Both operating and maintenance costs have been within the estimated amounts.

The Panoma gasoline plant is an outstanding example of the combination of engineering and experience of its designers, who emphasized operating and maintenance costs and process efficiency.

This plant was designed for the maximum recovery of products, minimum shrinkage of the gas thru-put, minimum operating and maintenance labor by extensive use of control instruments, selection of equipment that does not require frequent attention and maintenance, and a plant layout and process design to simplify and reduce the phases of operation to a minimum. Operating records of the plant are proof of attention given these factors of design.

Authors of the article, I. Earl Nutter and C. D. Van Vliet, are general superintendent of manufacturing, and chief engineer, respectively.

The gas supply being processed by the Panoma plant comes from 120 gas wells owned by the company, constituting approximately 77,000 acres, located in the eastern part of Texas County, Oklahoma. This acreage is very well blocked and, as a result, a minimum of pipe line footage was required to collect the gas into a common system. Considerable care was taken in laying out the pipe line system in order to locate meter stations from each lease adjacent to a section line so as to minimize the task of changing charts and servicing meters.

Panoma Corporation and Natural Gas Pipeline Company of America, the gas purchaser, worked together in the selection of the plant site for a location that would serve the best interests of both companies. The site selected for Panoma's plant is 110 acres of land, which was purchased outright, located approximately 17 miles northeast of Guymon, Oklahoma, and 2½ miles southwest of Hooker, Okla. This site is bordered on one side by the main line of the Rock Island Railroad and a paved highway. It provided easy access to the highway with a minimum of cost to the company to construct paved roads from the highway to the plant location. It also afforded a location requiring the minimum expense for the construction of a railroad spur into the plant yard, which proved to be of considerable value during the period of construction as well as a perpetual convenience for the loading of tank cars immediately adjacent to the plant site.

Selection of Type Plant

Panoma, in making a gas sales contract for the residue gas, obtained various contract provisions which contributed largely to the simplification of the type plant built. The purchaser boosts the gas in their compressor station before it is processed by Panoma. Fuel for the plant operation is residue gas, thus the plant gets the advantage of extracting the production from all gas delivered to the intake of the pipe line company's compressor station. Originally the purchaser was to use unprocessed gas for its fuel, but a later agreement provides that so long as their engines will operate satisfactorily the purchaser will obtain its fuel supply from Panoma's residue gas system, thus permitting the extrac-

tion of production from this gas volume also.

The price of the gas is based on a 965 Btu., determined at 30 inches of mercury and dry, but the price paid for the residue gas is adjusted proportionately up or down in direct proportion to the variation in Btu. value. However, no heating value lower than 960 Btu. shall be delivered to the purchaser without penalty. It was provided in the gas sales contract that Panoma was to install a dehydration plant on the outlet of the extraction plant and to maintain the dew point of the gas at all times to at least as low as 25° F. at 725 psig.

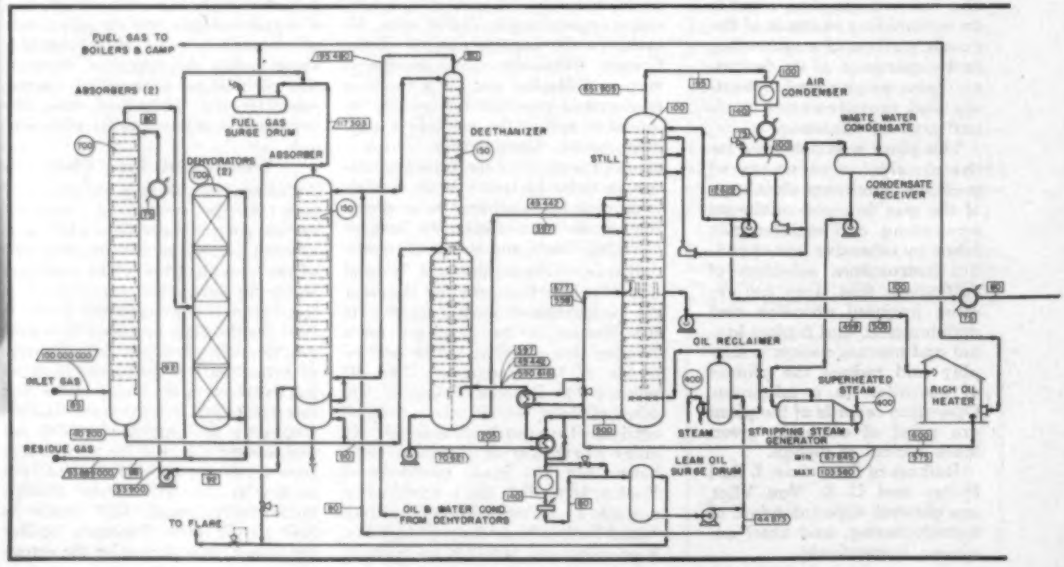
The plant was designed for the maximum recovery of liquid hydrocarbons under average summertime weather conditions; minimum shrinkage of gas throughput for production and fuel; minimum requirements of operating and maintenance labor by extensive use of control instruments; selection of equipment which does not require frequent attention and maintenance; and a plant layout and process design to simplify and reduce the phases of operation to a minimum, and yet accomplish the desired manufacturing results.

Panoma Corporation owns and operates the pipe line gathering system and meter stations for the transportation and measurement of the gas from its 120 gas wells to a central point located approximately one-half mile west of the gasoline plant site. It is at this central collecting point that Natural Gas Pipeline Company of America owns and operates its compressor station. The gas enters the intake of this compressor station at the maximum available natural pressure from the gas wells, which, at the present time, is around 270 psig., and is compressed by Natural to approximately 680 psig. After being cooled in the compressor station's gas coolers, it is delivered to Panoma's natural gasoline plant through Natural's 26-inch pipe line, where it is processed for the recovery of the available liquid hydrocarbons that may be obtained in reducing the gas to 965 Btu. The gas from the absorbers of the plant enters Panoma's dehydration towers where it is reduced to approximately 20° F. dew point at the above mentioned operating pressure of approximately 680 psig. After being dehydrated, the residue gas is returned to Natural's 26-inch pipe line at the edge of the plant yard, and finally is metered in Natural's metering station some 500 yards beyond the point the gas is returned to them from the gasoline plant. At the metering station a recording calorimeter and recording dew point instrument are operated by Natural for the determination of the gas quality. Remote recording calorimeters are located in both Panoma's plant and Natural's booster station so that the operators at both places may at all times make sure that the heating value is within the contract requirements.

Estimated and Accomplished Performance

The plant was designed to process 100 million cubic feet of gas daily, but it was also anticipated that the plant might later have available an additional 40 million cubic feet of a higher nitrogen content gas to be processed. Quality tests on this 40 million cubic foot volume indicated that only approximately 26-pound product, or the pentanes and heavier, and an additional moderate quantity of butanes, could be recovered from this extra gas in meeting the heating value requirement of the residue gas sales contract of 965 Btus. Except for one extra absorber, it was found that the existing extraction plant, designed to process 100 million cubic feet daily to the degree herein represented for design and actual operation, involving the oil circulation system, would process the total 140 million cubic feet daily, but additional distillation, vapor recovery and fractionation capacity was needed. Thus, on the flow diagram, Figure 1, the volume of production to be handled by the distillation unit and fractionators represents the total production from 140 million cubic feet daily, or the 100 million cubic feet yielding the recoveries herein tabulated and the 40 million cubic feet possible additional gas that might be processed yielding only approximately a 26-pound product. This explanation is necessary so that readers may follow the volumes repre-

Figure 1. Flow chart of Panoma Plant (see also page opposite)



sented by the flow sheet accompanying this article.

The gas analyses and yields for a 100 million cubic foot daily throughput are shown in Table 1.

The first portion of the Table 1 tabulation, captioned as "Design Analysis and Yield," represents an average analysis of 12 key wells tested prior to designing the plant and the anticipated product recovery. The second portion, captioned as "Recent Analysis and Plant Recovery," represents an analysis made on the plant inlet January 5, 1951, and the average daily product recovery for the period of January 1-10, inclusive, 1951.

An increase in propane and decrease in butane recoveries for this period from that of design resulted from adjustment of operation for increased propane recovery together with the return of extracted butanes to the residue gas in the lean oil to the absorbers to maintain the minimum Btu. content requirement of the residue gas. In this connection, the plant appeared capable of handling the designed capacity of gas with about a 45-percent propane recovery as compared with about a 34-percent design propane recovery.

TABLE 1

Components	DESIGN ANALYSIS AND YIELD (Calc.)		RECENT ANALYSIS AND PLANT RECOVERY	
	Mol. Percent	GPM @ 16.4	Mol. Percent	GPM @ 16.4
O_2	0.20	.....	0.15	.....
N_2	12.35	.....	12.30	.....
C_1	74.01	.....	78.01	.....
C_2	0.57	.....	0.56	.....
C_3	3.88	0.4743	3.91	0.5451
C_4	1.49	0.5118	1.46	0.4602
i-C_5	0.18	0.0703	0.20	0.0804
n-C_5	0.20	0.0806	0.19	0.0774
C_6+	0.32	0.1460	0.23	0.1042
Total	100.0	1.2920	100.00	1.2673

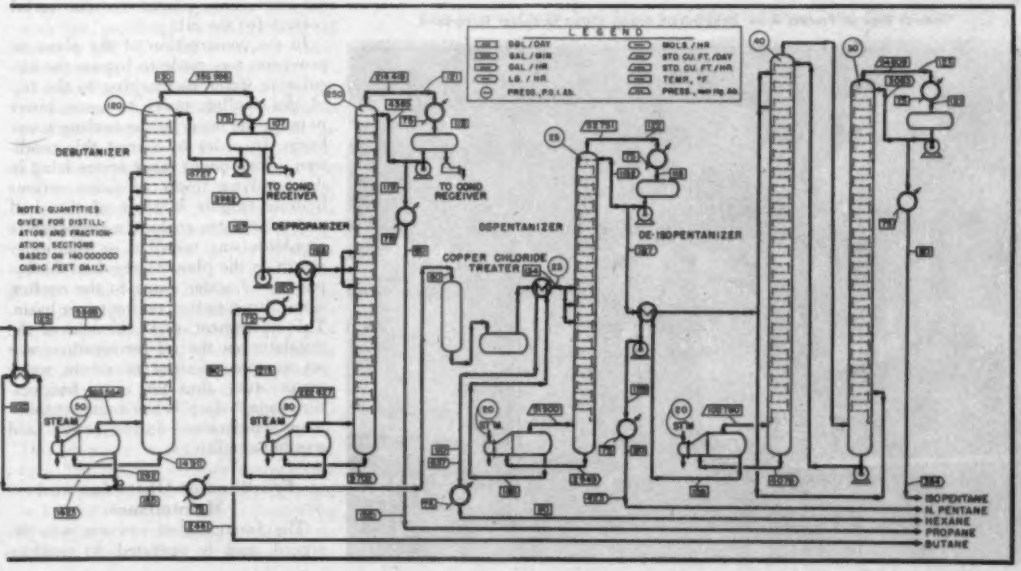
Unique Process Features

Perhaps the most outstanding feature at the plant is that of the relatively high recovery of propane and butane by rich oil rectification and vapor recovery without the use of compressors, and the return of relatively high Btu. components to the residue gas, thus enabling the plant to recover the maximum production with the minimum reduction of the heating value of the residue gas. This accomplishment is made by the use of a rich oil de-ethanizer receiving the rich oil direct from the absorbers wherein the base is reboiled against the hot oil leaving the still and the top is refluxed with a portion of the main lean oil stream.

The waste gases evolved in this operation are passed through a reabsorber against the remaining portion of the lean oil enroute to the absorbers, and after being cooled, enters the absorbers where the contained hydrocarbons of good heating value are exhausted or returned to the main gas stream passing the plant. The rich oil which has been rectified in the rich oil de-ethanizer, being free of all ethane and lighter, enters the 28-tray still 11 trays from the top. Upon passing the eighteenth tray from the top, the oil enters a doughnut section which, in effect, is an accumulator, where the oil is picked up by a hot oil circulation pump and passed through a direct fired heater, with a portion of same flashing as it re-enters the doughnut tray of the still.

The oil entering the doughnut tray overflows into a downcomer in the same fashion as from a tray and passes over the ten remaining trays in the base of the still where it is brought into contact with stripping steam. The operation of the heating cycle from and to the doughnut tray to the direct fired heater is a complete circulation system within itself and may be circulated at any degree of oil entering and leaving the doughnut tray as it passes the still, thus the direct fired heater may be operated at wide ranges of plant capacity without any danger of too low a rate causing coking.

The vapors leaving the top of the still, which, as aforementioned, are ethane and lighter free and contain only product that will result in a finished production, enter aerial condensers and coolers at a temperature of approximately 200°. From these aerial condensers the vapors enter a shell and tube type condenser and cooler where they are totally condensed and partially cooled before entering a raw product accumulator



located directly underneath. This condenser and cooler is located directly over the control room and, within the control room directly under this raw product accumulator, the product is pumped with part of the stream returning to the top of the still as reflux for end point control of the product, and the balance is discharged to the first fractionator of the fractionator system, which is the debutanizer. This raw product accumulator is equipped with a full range level controller which records the level of product with a second pen arm on the rate of flow controller metering to the debutanizer. This level controller is also equipped with a limit switch connected to a horn and red signal light inside the control room to warn the operator when the level in the accumulator becomes abnormally low.

The still pressure, under designed and operating conditions, operates at 100 psia. and is controlled by a recording pressure controller regulating the volume of water passing the shell and tube condenser and cooler located between the vapor aerial coolers and the raw product accumulator. This system has worked excellently ever since the plant started, even under the most severe summertime conditions, indicating that an excellent job has been done in rich oil rectification in the rich oil de-ethanizer.

The rich oil leaving the base of the still passes the heat exchangers wherein the aforementioned heating is applied to the base of the de-ethanizer. The oil leaves the heat exchangers at around 220° F. and enters a group of aerial coolers where the temperature is reduced to approximately 120° F. After leaving the aerial coolers the lean oil enters a group of atmospheric type coils in the base of one section of the main cooling tower, where it may be cooled to within 10° of wet bulb temperature during the summer, thence passes to the surge tank.

Four oil circulation pumps are used in the oil circulation system. The first pump, which may be called the primary lean oil pump, takes suction from the surge tank and discharges to both the rich oil de-ethanizer and the reabsorber through rate of flow controllers. The second pump, which may be called the secondary lean oil pump, takes suction from the base of the reabsorber and discharges to the two main absorbers through individual rate of flow controllers. A third pump takes suction from one side of the two-compartment base in the de-ethanizer, where the oil coming down the tower enters, and discharges through the heat exchangers back into the base of the de-ethanizer in the other compartment. A fourth pump takes suction from the doughnut tray in the still and discharges through the direct fired heater back into the doughnut tray on the still as aforementioned.

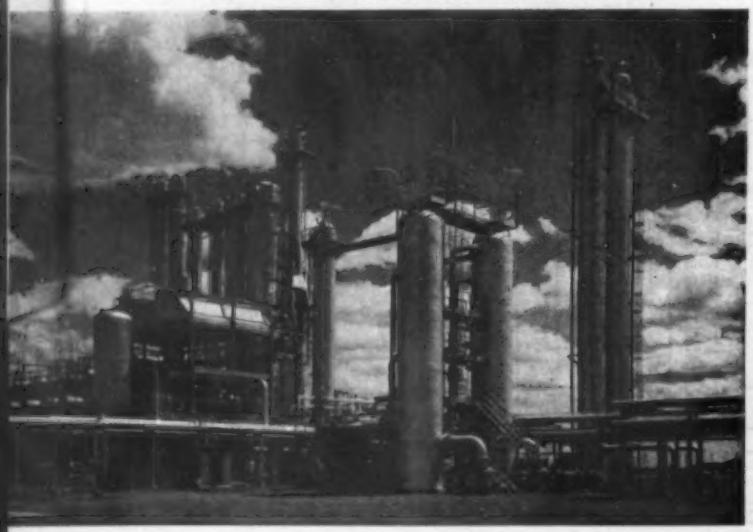
All four of these pumping services are equipped with full-sized standby units. The second pump above mentioned is powered by a steam turbine which exhausts into a 50-pound steam header for further use in the reboiler of the de-butanizer fractionator. The first and fourth pumps are also powered by steam turbines. These two turbines exhaust into a 20-pound steam header which supplies reboiler heat for the remaining fractionators.

The pressure on the main absorbers is not regulated and is that at which the pipe line operates at all times. This pressure is quite constant and offers no problem in operation. The pressure on the de-ethanizer and reabsorber is handled as a system, with the stripped vapors leaving the top of the reabsorber being controlled by an instrument type back pressure regulator which discharges directly into the fuel tank.

Upon putting the plant into operation November 11, 1948, it was soon found that with severe cold weather excessive cooling of the still vapors in the aerial condensers, and oil cooling in the aerial and water cooled condensers, offered a severe problem. Shortly thereafter enclosures were placed on the aerial coolers so that the flow of air, which was found to be too much even with the fans entirely shut off, could be eliminated. A temperature regulator, operating from the oil temperature in the surge tank to bypass a stream of hot oil direct from the heat exchangers to the surge tank, was also installed in order that the lean oil in the surge tank could not drop below some set minimum temperature. This was done to avoid hydrate formation in the high pressure absorbers, which occurred in spite of the enclosures placed on the aerial coolers for the oil.

In the construction of the plant no provision was made to bypass the circulating water discharging to the top of the cooling tower to some lower point in the tower or the cooling tower basin. In order to correct this condition, which might cause severe icing in the cooling tower or cause serious hydrate trouble in some of the shell and tube water coolers, a temperature regulator was installed on the water return to the plant to regulate the bypassing of water going to the cooling tower direct to the cooling tower basin. This instrument, as in the case of the regulator on the oil temperature, was set at some desired minimum water temperature, thus the water temperature cannot drop below some set minimum temperature during severe cold weather conditions.

General View of Process Area. Dehydration towers shown in center foreground.



Fractionator Operation and Maintenance

The fractionation system was designed, and is operated, to produce

propane, butanes, iso-pentane, normal pentane and a base stock with a vapor pressure of 4 to 6 pounds Reid vapor pressure. This base stock is blended with butanes or normal pentane, or both, for volatility regulation in the production of motor fuel. Both regular and premium grade motor fuel are produced from these ingredients by the proper addition of tetra-ethyl lead in a weigh tank type tetra-ethyl blending system located at the plant.

The sequence of fractionation employed affords a most economical approach to make the purity separations desired by the reduction of the reboiling and refluxing loads to the minimum. Maintenance is also reduced to a minimum by this approach to fractionation through moderate temperature spreads between materials to be heated and cooled and steam and water temperatures. In the case of steam heating of reboilers, the temperature spread between the steam and material heated does not cause vapor shielding of the outside surfaces of the tubes, which is so often encountered, and when encountered not only requires extra surface, but is quite a shock condition on the heating elements. In the case of cooling, the streams to be condensed and cooled are sufficiently low to prevent rapid and severe scaling in the water sections.

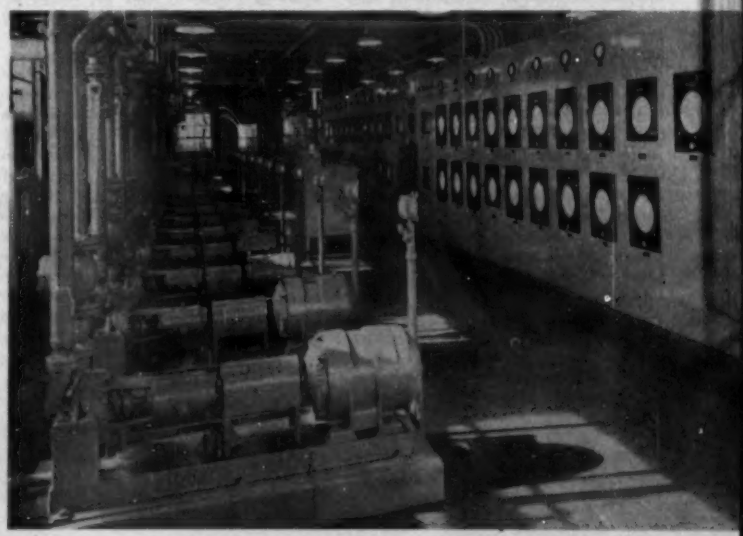
In the sequence of operation the raw product is fed to the de-butanizer where it is separated into butanes and lighter as an overhead product, and pentanes and heavier as a base product. This operation is accomplished at approximately 125 pounds absolute, with an overhead temperature of around 130° F. and a reboiler temperature of approximately 260° F. The overhead product is fed to the de-propanizer where finished propane is produced overhead and finished butanes are produced as a base stock. The de-propanizer is operated at 250 psia. with an overhead temperature of approximately 120° F. and a reboiler temperature of approximately 215° F. The base stock from the de-butanizer is the feed stock for the de-pentanizer, where both normal and iso-pentane, as an aggregate, are separated from the hexanes and heavier, however, a portion of the normal pentane may or may not be retained in the base stock, depending on the seasonal requirements of volatility of the motor fuels to be produced during various seasons. This de-pentanizer is operated at 25 psia. The overhead vapor temperature is 120° and the reboiler temperature is approximately 200°, depending upon the material being produced as a base stock. The overhead vapors from the de-pentanizer are fed to the de-iso-pentanizer, where the iso-pentane is made as an overhead product and the normal pentane as a base stock. The de-iso-pentanizer operates at 40 psia. with the overhead temperature being approximately 130° and the reboiler temperature being approximately 160°.

In all of these systems of fractionation the overhead vapors enter a shell and tube type water cooled vapor condenser and cooler located directly over a 6 x 20-foot overhead product accumulator. The pressure on each of these fractionation systems is regulated by means of a recording pressure controller, controlling the flow of water to these vapor condensers and coolers. In so doing, the operating pressures of these accumulators are at a maximum and are the same as the pressure on the fractionators themselves, thus the temperature of the product accumulated is only a partially cooled material, and in the instances of a pure product being produced overhead, the temperature is approximately the same as the temperature of the top of the column, with only latent heat being removed. It is believed that this is a most ideal condition, because the material being returned to the tops of the fractionators as reflux is at its boiling point. In all instances the full steam pressure of the exhaust systems are used in the reboiler elements of the fractionators, with the temperature being regulated by the withdrawal of steam condensate from the heating elements, thus, at all times, the reboiler elements are operating partially filled with condensate. Had this arrangement not been used, and the conventional steam control valve used, resulting in a pressure drop in the steam to supply steam to the reboiler, it is doubtful that there would have been sufficient steam temperature to obtain the necessary heat input.

The temperature on each of the fractionators is regulated from a control point located between the feed entry and the reboiler. This location of control point, which may be moved between three alternate points over a spread of six trays, is a variable distance from the reboiler among the different fractionation services dependent upon the nature of the feed and other conditions of operation. This control point up the tower is employed because in each instance a separation, as close as possible, is being made between two components.

If the temperatures of the reboilers were maintained at a constant point, a constant vapor pressure reboiler product would be made which would not necessarily be a separation exactly between the two products desired, and would include some of the next lighter hydrocarbon or give up some of the lighter fraction in the reboiler in order to maintain a fixed vapor pressure. However, with the control point up the column while producing a multi-component reboiler product, the vapor pressure of the product will vary slightly because of the variable ratio

View Showing Process Pump Room and Control Instrument Panel, Panama Plant.



of components in the reboiler product produced over a period of time. Of course, in the event of producing a one-component reboiler product, it is necessary to have this control point up the tower because the reboiler temperature would be the same whether the product was brought up to temperature or totally evaporated.

A mercury actuated indicating temperature transmitter is employed at each of these fractionation control points, with the transmitter located on the ground directly below the location of the control point on the side of the tower. This transmitter pneumatically operates a recording temperature controller located inside of the control room, on which the desired temperature to be held may be manually adjusted. As aforementioned, the heat input to the reboiler is regulated by the withdrawal of condensate from the heating elements. This condensate withdrawal line is equipped with an orifice flange and diaphragm valve. An indicating rate of flow control transmitter is located immediately adjacent to this orifice flange, which pneumatically transmits to a recording flow controller located inside of the control room in close proximity to the recording temperature controller. This rate of flow controller pneumatically operates the control valve on the condensate line at a constant rate as governed by the rate of flow controller. An automatic reset on this rate of flow controller is controlled from the recording temperature recorder, thus as temperature changes need take place, the automatic reset affects same by integral movements of the reset, thus stabilizing the effect of required temperature changes as needed as varying heat input conditions are encountered.

All products en route to storage are cooled through extended surface type water coölers and are metered by rate of flow controllers. The propane en route to storage passes through a dry desiccant type dehydration plant. The base product from the de-butanizer, before being fed to the de-pentanizer, is sweetened in copper chloride gasoline treaters. All the fractionator overhead product vapor condensers and accumulators are located over the control room directly above their respective reflux and feed pumps in the control room, and the accumulators are equipped with full range level controllers in the same fashion and for the same functions previously described for the raw gasoline product accumulator.

Storage and Loading System

The storage system of the plant consists of the following storage tanks:

4—10′ x 104′, 1500-barrel propane storage tanks
2—10,000-barrel spherical butane storage tanks
2—5000-barrel spheroidal pentane storage tanks
1—20,000-barrel floating roof gasoline storage tank
2—5000-barrel cone roof gasoline storage tanks
2—5000-barrel floating roof Ethyl blending tanks
3—10′ x 36′, 500 barrel raw gasoline storage tanks
3—10′ x 40′, 500 barrel motor fuel dispensing tanks.

The propane, butane and pentane storage tanks are of suitable pressure to safely withstand the vapor pressure of the product being stored, with each tank equipped with dual safety valves, and vacuum relief valves in the case of the pentane storage tanks. A loading pump house for transferring, rerunning, and for loading tank wagons and tank cars, is centrally located among the above mentioned group of storage. The floor of this loading pump house is approximately 8 feet below grade, with the walls of the building extending up normal height above the grade. Dual loading pumps handle propane and butane, individual pumps are used for each of the other products, and another pump is used for rerunning product, with its discharge pressure being sufficient to enter the rerun at any point desired in the fractionation system.

The suction lines to all of these pumps are buried from the respective storage tanks, with a gradual slope toward the pumps. In the case of the light hydrocarbon pumps, a return vent line is connected to the top of the pump and extends back to the vapor section of the tank. At all times all suction and vent lines to these pumps are left open to their respective storage tanks. The discharge lines from all loading pumps enter a header system on pipe stanchions and extend to the tank truck loading rack and the tank car loading rack immediately adjacent to the plant yard on the north side and south side respectively, thus all products may be pumped by their respective loading pumps to either of the loading points. These loading pumps are all powered by explosion-proof electric motors, with each having a control switch at the pump location and also remote control switches at each of the loading points. These remote control switches are equipped with indicating lights and locking devices so that an operator at either of the loading racks may know whether or not a pump is operating as indicated by the light on the switch, and may assure the continued operation of the pump by engaging the locking knob on the switch so that no other operator at some other remote control point can turn the pump off. With this system, therefore, the tank truck loaders and tank car loaders may load the same product simultaneously, and if a greater rate of pumping is desired because the product is being taken at both points, he may, in loading propane or butane, start up the auxiliary loading pump to furnish the necessary rate of loading.

The tank truck loading rack is equipped with four spots for loading propane and butane, and three spots for loading motor fuels by gravity from the elevated motor fuel dispensing tanks. The entire area constituting the tank truck loading rack is paved, and the loading lines, upon entering this paved area, are in conduits through the concrete paving to a centrally located pipe trench, above which are installed the loading risers. This pipe trench is covered with steel grating so that the loading lines are easily accessible for repair or rearrangement if so desired in the future.

The tank car loading rack is six spots long, with trackage on each side, thus there are a total of 12 spots. At each spot risers are located for all of the products to be loaded so that the operator may load any product desired at any point on the rack. Switches for operation of the loading pumps are located at the central point near the middle of the rack.

End of Part I. Part II will appear in an early issue.

* * *

Maintenance Facilities in Gasoline Cycling Plants

HOMER GIVENS, Superintendent
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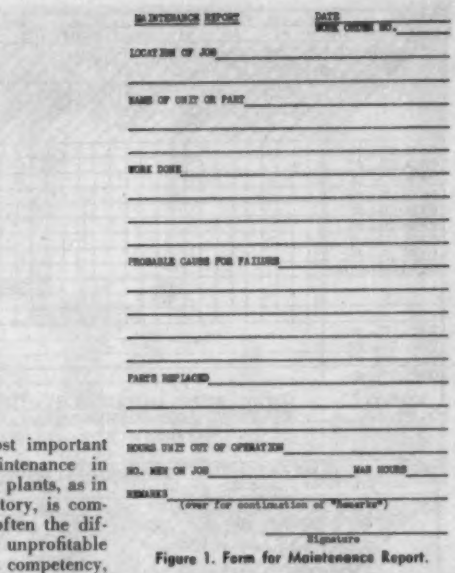
DOWNTIME for plant repairs is responsible for high operating cost and for more sleepless nights for operators, from superintendents to laborers, than any other single factor in plant operation. It is a constant threat even to well-managed plants. Maintenance men, constantly checking and repairing the hundreds of items of equipment, work around the clock, to keep the plant at peak efficiency and prevent unscheduled downtime.

It has been said that the workman is limited by the quality of his tools. Whether this holds in maintenance of gasoline and cycling plants might be debated; however, the industry has learned that competent maintenance personnel, plus the tools and equipment they require, are vital to profitable operation of the plants.

THE first and most important facility of maintenance in gasoline cycling plants, as in any kind of plant or factory, is competent personnel. Quite often the difference in a profitable or unprofitable operation depends on the competency, congeniality, and ingenuity of the maintenance department.

The average gasoline and gas cycling plant has many types of machinery, but seldom enough of any one type to require an expert mechanic for that particular type. Therefore, these plants have a man in charge of maintenance, called by various titles such as chief engineer, maintenance foreman, or plant repair supervisor. This man is usually second in command at the plant and has had both maintenance and operating experience. He should have had some education along mechanical or chemical engineering lines and be an expert mechanic. Also, he must be a diplomat in that he must have the viewpoint of management and command the respect and confidence of the employes working under him.

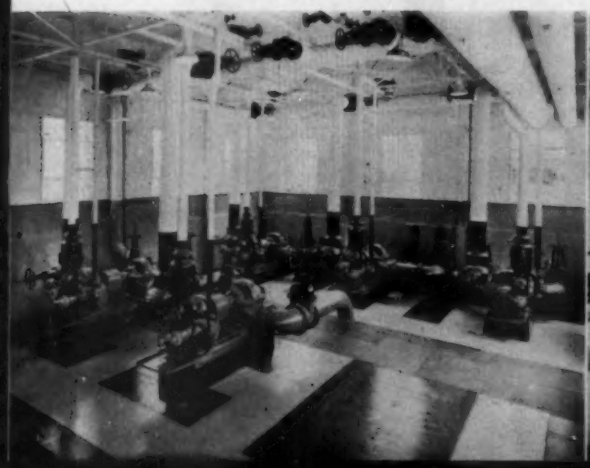
The next important member of the maintenance crew is the gas engine-compressor mechanic. The gas engine-compressors are the heart of any gasoline-cycling plant, since it depends on the flow of gas for its production; therefore, a minimum of downtime of compressors is mandatory. This man should have had considerable experience in operating gas engine-compressors and be able to analyze any trouble and repair it in the shortest time possible. An understanding of the en-

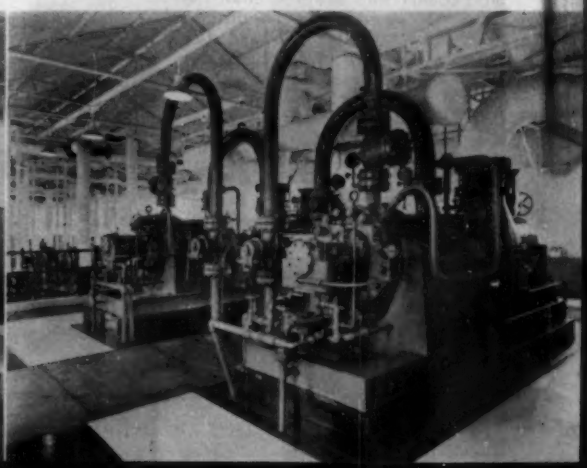


No. INTERRANCE REPORT DATE
WORK ORDER NO.
LOCATION OF JOB
NAME OF UNIT OR PART
WORK DONE
PROBABLE CAUSE FOR FAILURE
PARTS REPLACED
HOURS UNIT OUT OF OPERATION
NO. MEN ON JOB MAN HOURS
REMARKS
(over for continuation of "Remarks")
Signature

Figure 1. Form for Maintenance Report.

Figure 2 (Left)—Water Pumps in Pump House of a Gasoline-Gas Cycling Plant. This view emphasizes the first law of plant maintenance—good housekeeping. Figure 3 (Right)—Steam Turbine-Driven, Eight-Stage, Centrifugal High-Pressure Lean Oil Pumps in a Gas Cycling Plant. Note the careful housekeeping.





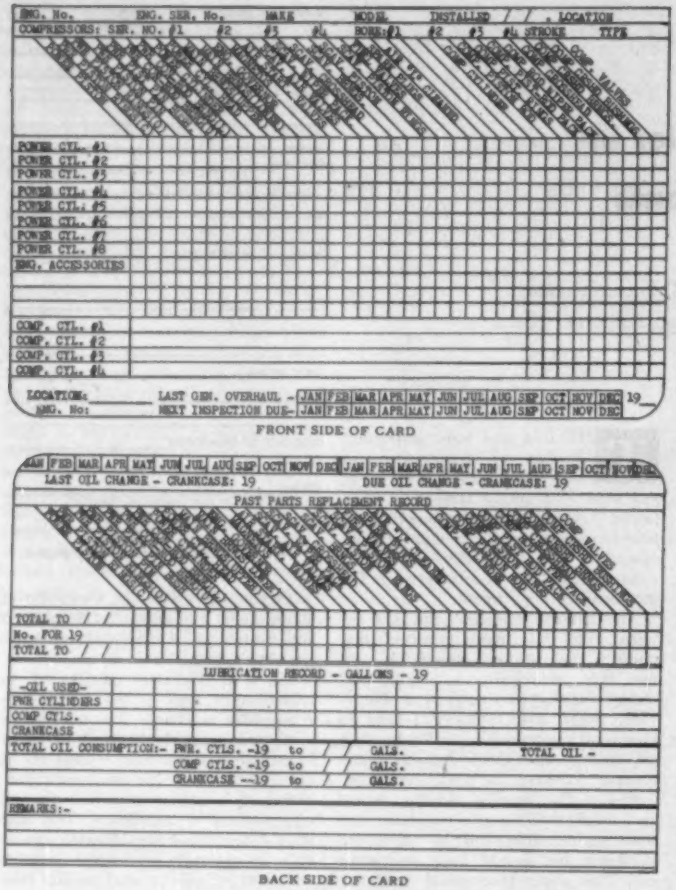

ENG. No.
ENG. SER. No.
MAKE
MODEL
INSTALLED
LOCATION
COMPRESSORS: SER. NO. #1 #2 #3 #4
BORE: #1 #2 #3 #4 STROKE
TYPE
POWER CYL. #1
POWER CYL. #2
POWER CYL. #3
POWER CYL. #4
POWER CYL. #5
POWER CYL. #6
POWER CYL. #7
POWER CYL. #8
ENG. ACCESSORIES
COMP. CYL. #1
COMP. CYL. #2
COMP. CYL. #3
COMP. CYL. #4
LOCATION:
ENG. No:
LAST GEN. OVERHAUL - JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC 19
NEXT INSPECTION DUE- JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
FRONT SIDE OF CARD
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
LAST OIL CHANGE - CRANKCASE: 19
DUE OIL CHANGE - CRANKCASE: 19
PAST PARTS REPLACEMENT RECORD
TOTAL TO / /
No. FOR 19
TOTAL TO / /
LUBRICATION RECORD - GALLONS - 19
-OIL USED-
PWR CYLINDERS
COMP CYLS.
CRANKCASE
TOTAL OIL CONSUMPTION:- PWR. CYLS. -19 to / / GALS.
COMP CYLS. -19 to / / GALS.
CRANKCASE --19 to / / GALS.
TOTAL OIL -
REMARKS:-
BACK SIDE OF CARD

Figure 4. Suggested Record Form.

gineering problems of gas engines and gas compressors is a great asset in his work.

The average plant has the gas engine-compressor units sized in such a manner that with one unit down the capacity is not reduced more than 15 or 20 percent. On this basis, and after the units have been broken in, the gas engine-compressor mechanic can take care of about 600 horsepower with help from the roustabout crew on the overhaul jobs. After 600 horsepower, he can use a full time man for each additional 2000 horsepower. However, he will still need additional help from the roustabout force on overhaul jobs.

If the plant has reciprocating or steam turbine driven centrifugal pumps, one pump mechanic with occasional help from the roustabouts can keep them in proper repair. However, if the drive is electric motors the plant will need a full time electrician who will work closely with the pump mechanic. The pump mechanic must be as good a man in his line as the gas engine-compressor mechanic is in his.

Many plants can utilize a yard foreman to good advantage. He should supervise pipe-fitting jobs, condenser and cooler cleaning, painting, boiler cleaning, and other miscellaneous jobs not connected with operating machinery.

As already stated, if the majority of power is electric motors, a full time electrician is necessary. This applies whether electricity is purchased or generated on the site.

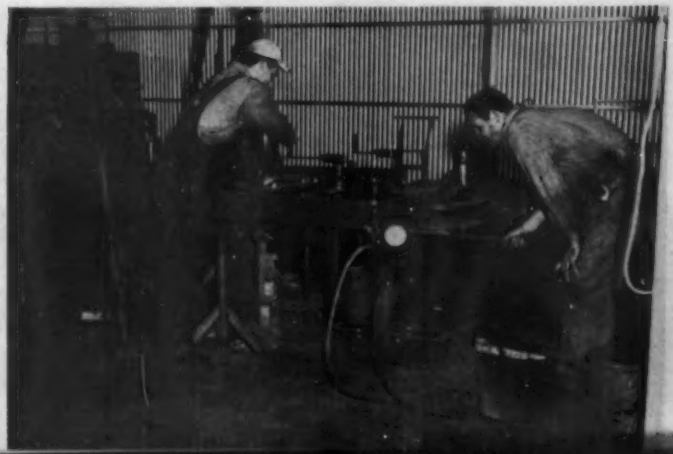
Another skilled member of the maintenance force is the instrument man. He shoud not be considered the least important because he is named last. Quite often it is the ingenuity of the "gadget fixer", as he is frequently called, that prevents a costly shutdown or the calling in of expensive consultants. In our hypothetical plant the instrument man, with a helper from the roustabout gang, as needed, can keep the instruments drawing a circle.

A plant's roustabouts should be semi-skilled men with potential capabilities of filling one of the skilled places previously described. The necessary number of these workers usually must be determined after a considerable period of operation. In many cases laborers may be temporary employes only.

Next to be considered are the inanimate facilities. The first of these are the ordinary hand tools. These consist of wrenches (adjustable, socket and box socket, end and Allen), hammers, pliers, screwdrivers and small special tools. In the majority of cases it is more economical to issue each mechanic these tools with a box he can keep locked.

In the shop a large panel board with either hooks or magnets to hold the above list of tools, as well as the larger tools such as gear pullers, pipe wrenches, sledge hammers, pipe and bolt dies, and prying bars, should be

Figure 5. Using a 100-Ton Hydraulic Press.



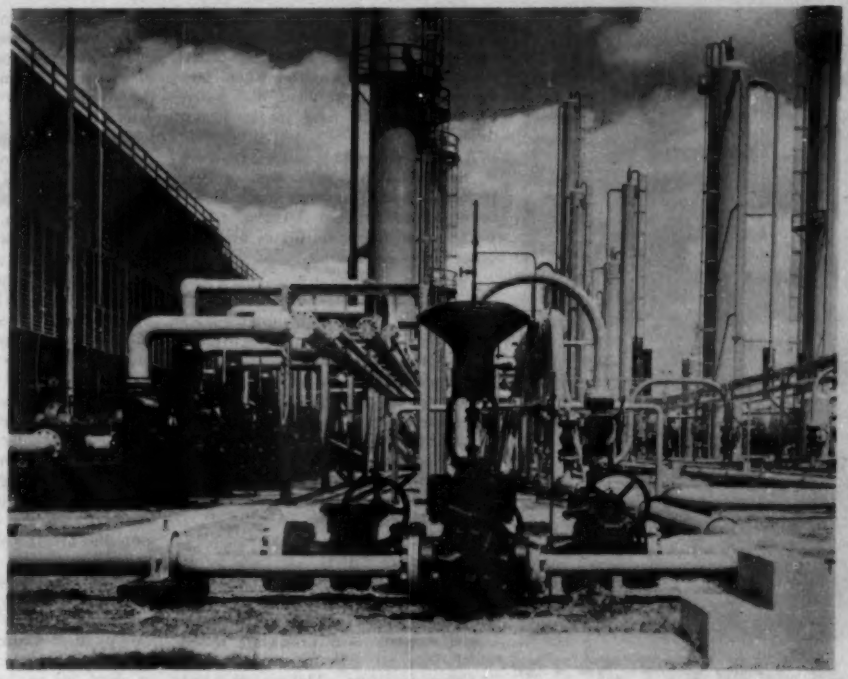


Figure 6. Absorbers, Fractionating Towers, and Pumps in a Gas Cycling Plant . . . Regulator in foreground, is six-inch-900-pound passing 250 million cubic feet of wet gas dropping pressure from 1900 psi. to 1500 psi.

Pictures Below:

Figure 7 (Left). Absorbers and Fractionating Towers in Gas Cycling Plant.

Figure 8 (Right). Preparing to "Pull" Piston of 800-h.p. Gas Compressor Engines.

provided. A good psychological effect is obtained by painting this board white with each particular tool spot painted black, in the shape of the tool which is to occupy that spot.

The shop also should be equipped with an electric driven grinder and wire brush, a drill press, power hack-saw, a screw or hydraulic press preferably 75 tons or larger capacity, and vises. Usually an electric welding machine and an acetylene cutting and welding outfit are a profitable investment. A small electric impact wrench is a great time-saver and will pay for

Figure 9. Drilling Out Water Tubes in Gas Cooler.

itself in a short time. An overhead traveling hoist of about a two-ton capacity should be standard shop equipment also.

The gas engine-compressor building should be equipped with an overhead traveling hoist to handle heavy parts of the engines. If this hoist is electric motor driven much time will be saved. A large air motor driven impact wrench and one or two five-ton capacity hydraulic jacks are necessary equipment when repairing modern gas engines. A spark plug cleaner and tester should be provided to get maximum service from spark plugs.

An air-motor driven drill is essential to clean tubes in shell and tube coolers and condensers. This drill is also necessary when drilling in locations where an electric drill would be hazardous because of gas or gasoline vapors.

If water-tube boilers are installed, then a water turbine driven "rattler" to clean the scale from the tubes must be standard equipment. Air-driven cleaners can be used, but some boiler insurance companies frown upon their use.

Most of the modern plants have direct-fired rich oil heaters and, although coking is not a serious problem, a tube cleaner should be kept on hand. Some kinds of heaters use small tubes, the same size as boiler tubes, and if this is considered when purchasing initial equipment, the boiler "rattler" may be used in the heater tubes.

A one and one-half ton winch truck is needed along with one or two pick-up trucks. The winch truck should be equipped with an A-frame or gin pole to facilitate handling of pipe and other heavy equipment.

Shop Machines

Although every plant maintenance man would like to have a large lathe, it is not always economical to purchase one. After the plant has been operating several months, it can be determined from cost sheets, the size of the lathe that could support itself, if one is needed. It must be remembered that a lathe necessitates that a competent machinist be available to operate it at any time.

Other shop machines such as shapers, gear cutters, etc., are in the same category with lathes. However, a pipe and nipple threading machine, handling pipe sizes ⅛-inch through 2-inch usually is a profitable investment.

Other facilities of importance are the maintenance reports and records. The reports should be filled in by the head mechanic for the type of machine he services, or the operating crew when they change a compressor valve, engine fuel valve, magneto or spark plug during the night shifts or weekends. These reports should be collected and entered on the record cards by some member of the organization—not a member of the maintenance crew.

Figures 1 and 4 show the maintenance report and record forms, respectively. These forms were designed by a member of the author's organization, and are proving a great benefit to the maintenance crew.

The maintenance report is designed to make it as simple as possible for the mechanics to report their work. This form can be used for all maintenance work in the plant; however, it may be printed for each class of machinery if desired.

The maintenance record cards should be made for each class of machinery. The example shown is for gas engine-compressors, and separate ones would be used for pumps, turbines, cooling tower fans, etc. The record cards are filed in a simple and easily accessible file and the maintenance work entered on them from the maintenance reports as they are turned in by the mechanics.

After these records are kept and referred to several months, many maintenance jobs can be anticipated and handled during slack periods, thereby preventing severe break-downs. This procedure is called preventive maintenance and is becoming quite popular in all kinds of plants. These records will also help determine any additional facilities, both animate and inanimate, that will be economical.

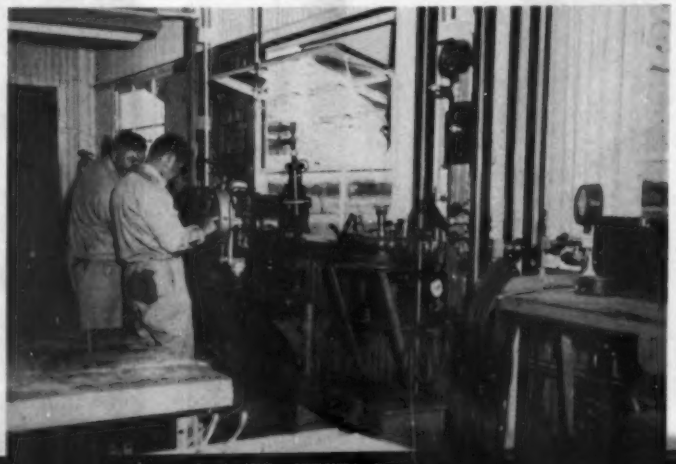
Conclusion

In conclusion, it should be stated that the writer realizes, as well as anyone, that no hard and fast rules of maintenance can be made for an industry such as gasoline-gas cycling plants. This is especially true because gas capacities range in volume from 20 million to 500 million cubic feet, and plant sites vary in locations from next door to cities, to great distances from the nearest railroad stops. However, he hopes that some of the ideas advanced here will aid the cycling plant man's naturally high initiative in working out his particular problems.

ACKNOWLEDGMENT

Photos used as Figures 5, 8, 9 and 10 are by Mrs. Carol Dryden, Falfurrias, Texas, and Figures 2, 6 and 7 by Elwood M. Payne, Houston.

Figure 10. Repairing Meters in Instrument Shop.



Portable Low-Temperature Processing Equipment

GEORGE F. RUSSELL
Gas Processing Engineer, Houston

ECONOMIC factors involved in processing small quantities of gas for the liquid content in field locations remote from markets often make the construction of conventional process facilities too costly for consideration for small plants. During the past several years the utilization of portable low temperature processing equipment for handling small quantities of gas ahead of pipe line sales, has received attention from both the producers of gas and the natural gasoline industry.

The use of low temperature processing equipment has proven economically feasible, as well as a practical method for fuel conservation. Simultaneous automatic dehydration of the gas to pipe line requirements is an important feature of this method.

IMPORTANT advances recently have been made in natural gas processing techniques whereby the refrigerating potential of expanding gas is utilized. Two principle benefits have been realized from the improved techniques which utilize the naturally occuring high wellhead pressure, namely: 1) increased hydrocarbon condensate, or gasoline recovery, and 2) greatly reduced water vapor content of the effluent gas.

Although the importance of operating oil and gas separators at minimum practicable temperatures for best liquid recoveries has been recognized by the producers of oil and gas, quantitative evaluations of the benefits to be derived from the low-temperature separator operation have been difficult to confirm due to such production variables as temperature, inlet gas pressure, and possible changes in gas-oil ratios with changes in gas production rates. However, increased knowledge of vapor-liquid equilibria for gas-condensate systems, combined with engineering application of natural gas reservoir mechanics, have made it possible to predict the performance of the improved extraction techniques.

As early as 1935, the advantages of withdrawing the excess water from the gas stream before reducing the gas pressure was demonstrated. However, the relatively high cost of the special equipment was seldom amortized from the then low priced distillate. Economically, the expenditure was not justified.

Today, with distillate values approaching $3.00 per barrel and marketing conditions steady and improving, gasoline extraction and gas dehydration in the field containing one or more wells offer some interesting dollar returns.

Gas Production Evolution

The history of the natural gas and gasoline industry is one for Horatio Alger, starting from an humble beginning and developing into one of the major industries of the United States. In an early day a gas well was classed only one step better than a dry hole, and all too often was plugged and abondoned.

With modern advances in well-drilling technology came deeper wells and the discovery of high-pressure gas formations. Production men observed that some of these high pressured wells produced a high gravity liquid, which if properly weathered, could be used as a low grade motor fuel. At times this liquid condensate, or distillate, was difficult to market

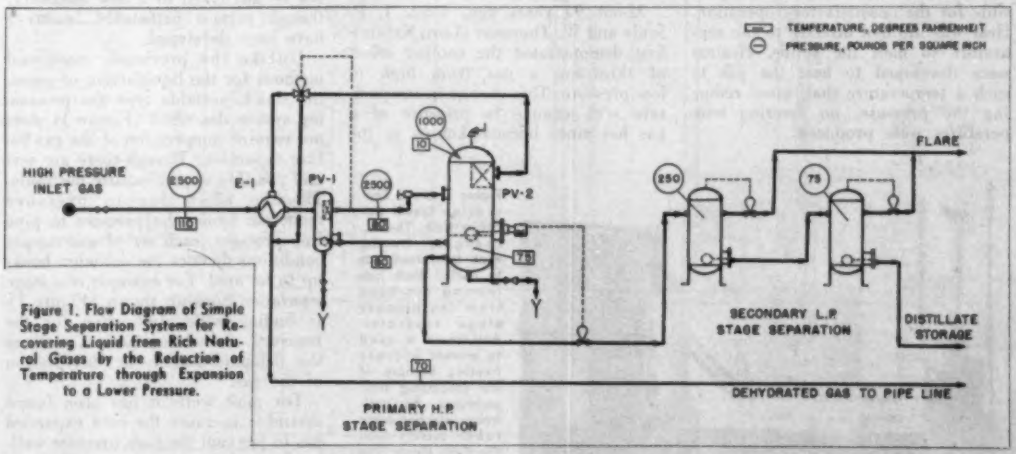


Figure 1. Flow Diagram of Simple Stage Separation System for Recovering Liquid from Rich Natural Gases by the Reduction of Temperature through Expansion to a Lower Pressure.

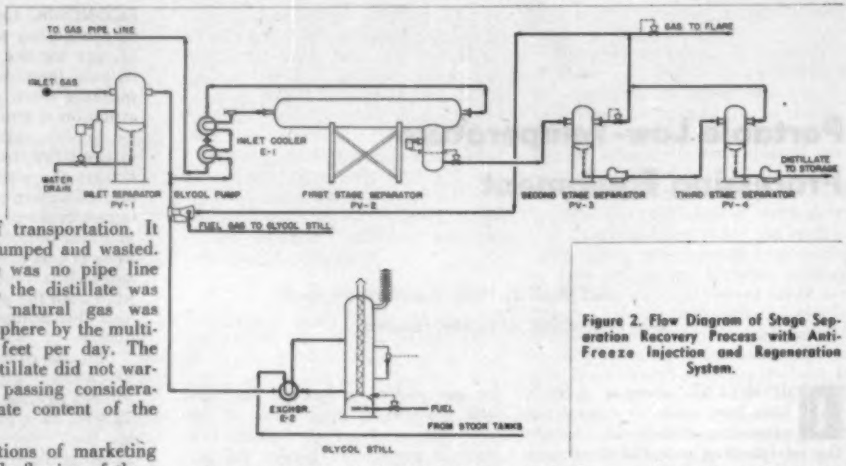


Figure 2. Flow Diagram of Stage Separation Recovery Process with Anti-Freeze Injection and Regeneration System.

because of lack of transportation. It was trapped and dumped and wasted. Often, where there was no pipe line outlet for the gas, the distillate was collected and the natural gas was vented to the atmosphere by the multi-millions of cubic feet per day. The selling price of distillate did not warrant more than a passing consideration of the distillate content of the separator vapors.

Where all conditions of marketing permitted, the steady flowing of these high pressured gas-distillate wells was not achieved without difficulties, the principle one being a tendency to freeze and obstruct the natural passage of gas. The free water produced along with the gas, formed the solid gas hydrates in the flow-control chokes, the lines and in the separators. In the cases where the gas was delivered into gas pipe lines for transmission, the erratic flow was very troublesome, to say the least.

One of the first and rather obvious attempts to overcome this tendency to freeze up was to drain the liquid water from the system before it was subjected to freezing temperatures. Until 1934, few engineers recognized the existence of what are now called natural gas hydrates, though many knew that icy and wax-like substances which could be melted, were responsible for the unsatisfactory operation. Heat was applied directly to the separators to melt the solids. Heaters were developed to heat the gas to such a temperature that, upon reducing the pressure, no freezing temperatures were produced.

Another early method used, to combat this tendency to freeze up due to auto-refrigeration, was to inject an alcohol anti-freeze into the gas stream. In order to inhibit all the water which might be produced along with the gas and distillate, excessive amounts of anti-freeze were required. It was difficult to anticipate the exact anti-freeze requirements, and there was no practical means to recover the alcohol for reuse. So, the unbridled used of anti-freeze was generally conceded to be an expensive answer to the problem.

Ultimately, because of its simplicity and ease of operation, the wellhead heater method of gas well flow control became the accepted conventional gas production practice of the oil and gas industry. The problem no longer existed.

About 99 years ago, 1852, J. P. Joule and W. Thomson (Lord Kelvin) first demonstrated the cooling effect of throttling a gas from high to low pressure. This change in temperature with change in pressure of a gas has since become known as the Joule-Thomson effect. At ordinary temperature and pressures the only gases which do not exhibit a lowering of temperature with a lowering of pressure are helium and hydrogen. However, under special conditions, all gases have been made to exhibit the Joule-Thomson effect which is basically a function of the internal energy of the gas. In fact, it is not uncommon for natural gases above 3000 psi. to exhibit a negative Joule-Thomson coefficient.

Present-day commercial applications include the extraction of oxygen and nitrogen from the atmosphere. The U. S. Bureau of Mines has been separating helium from natural gas for years with a modification of the general principle.

Hence, the present trend in low temperature gas well processing can not be attributed to a new discovery, though certain patentable features have been developed.

Unlike the previously mentioned methods for the liquefaction of gases, the small, portable type gas processing system described (Figure 1) does not require compression of the gas before expansion. Though there are several possible ways to utilize the Joule-Thomson effect due to pressure reduction from inlet pressure to pipe line pressure, each set of gas supply conditions dictates the optimum hook-up to be used. For example, the stage separation hook-up shown (Figure 1) is finding wide application for the recovery of hydrocarbons as well as the dehumidification or dehydration of the gas.

For most wells it has been found desirable to cause the cold expanded gas to pre-cool the high pressure wellhead gas before expansion. For any

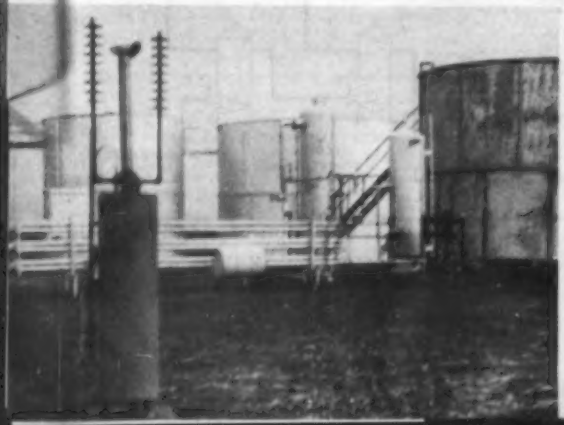


Figure 3. Stage Separation Liquid Recovery Unit. The exchangers transfer heat from feed gas to cooled flash gas leaving overhead from the primary stage separator. Anti-freeze is used to prevent hydrate freezing because of low processing temperatures. An anti-freeze injection pump takes suction from the drum shown. The small heater in the foreground supplies heat for glycol regeneration.

given system, the total amount of recovered liquids can be shown to vary inversely with the total heat content, or enthalpy, of the high pressure gas prior to the reduction in pressure.

Hence, normally, the inlet gas is cooled at the heat exchanger (E-1) to a temperature above the gas hydrate freezing point and the condensed water and/or hydrocarbons are withdrawn from the high pressure steam by use of the separator (PV-1). The liquids are thus not exposed to the frigid temperatures which are produced by the expanding gas. Also, the warm liquids provide the necessary heat in the bottom of the cold separator for melting any solids which might otherwise collect in the lower part of the separator.

The high-pressure gas is then throttled through the flow-control choke (V-1). Any liquids or dispersed solids, which precipitate from the gas when the temperature is suddenly reduced, naturally fall into the warm liquid which has been injected into the bottom of the separator. All the liquids are then withdrawn together, or separately as desired.

Because of the fact that the water vapor content of the gas has been greatly reduced due to the low temperature, the gas generally meets the most rigid specifications of gas purchasers.

Further, in the application of this type of gas processing, one readily sees the need of altering the size and ratings of the equipment to meet the temperatures and pressures of different wells.

A more efficient system such as suggested by Figure 4 is in some cases attractive. By using a stabilizer for the distillate, the production is stepped up from a nominal 13.3 barrels SCF standard cubic feet for hearter-separator operation to 18.1 barrels, or a 36 percent increase in production. This compares with 16.6 barrels or a 24.8 percent increase when using a typical low temperature stage separator. Where anti-freeze is used, it is regenerated in the distillate stabilizer; however, glycol makes up is greater than if regenerated separately.

Under certain conditions, particularly where the well flowing temperature or pressures are too low to provide the necessary heating for warming the bottom of the separator, it has been found necessary to inject glycol anti-freeze as is shown in Figure 2. The anti-freeze and condensate flow into the stock tanks where the water-rich glycol settles out in the bottom. A portion of the water is distilled from the glycol to regenerate the anti-freeze. The glycol also serves to lower the dew-point of the fluent pipe line gas, being the equivalent of a single tray dehydration contactor. Figure 3 is a picture of the set up which uses anti-freeze on the low temperature separator, increasing distillate production 25 percent.

Using low temperature as shown in the flow diagram (Figure 1), 20 to 99 percent of the natural gasoline content of a conventional separator tail gas can be extracted and recovered. The higher percentages of increased production are achieved from the gas from wells which flow the warmest.

As a generalization, one might estimate that an additional $10 to $20 million per year could be realized in net earning from processing of natural gas, if the gas-distillate well pressure of proven reserves were fully and efficiently exploited.

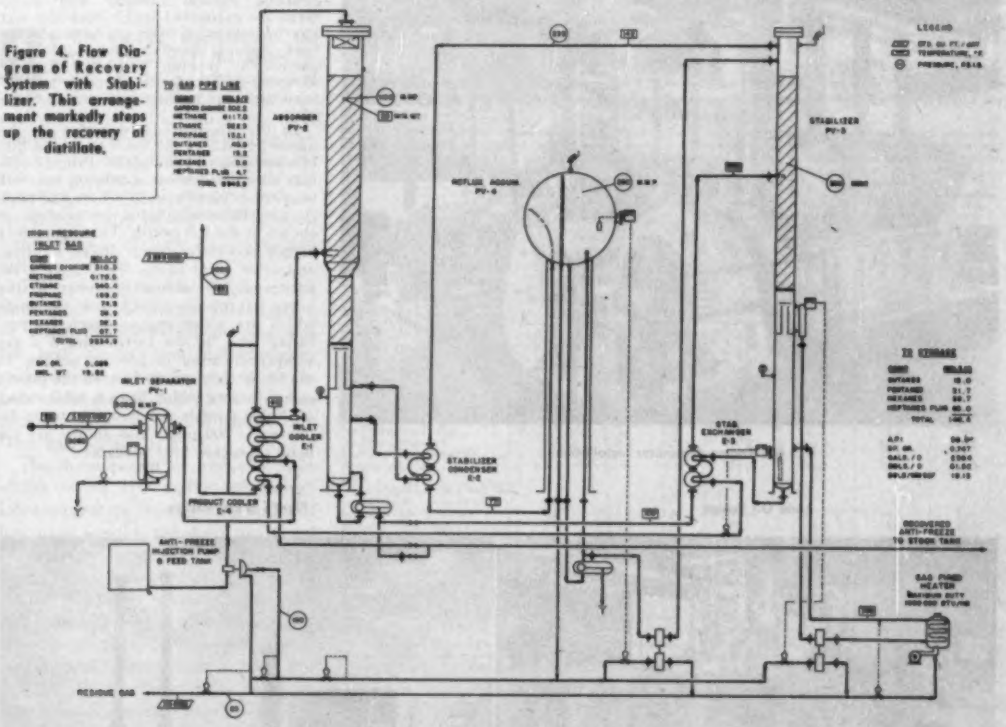


Figure 4. Flow Diagram of Recovery System with Stabilizer. This arrangement markedly steps up the recovery of distillate.

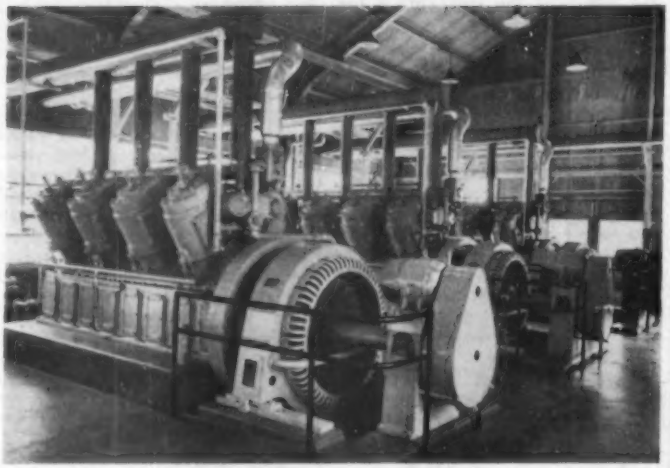
Absorption and Distillation Areas.

Shell's Provident City Gasoline Plant In Full Operation

SHELL Oil Company's new gasoline plant at Provident City, Texas, completed last June, is operating at full capacity following the completion of a 110-mile 16-inch pipe line which carries gas from the plant to Baytown, Texas.

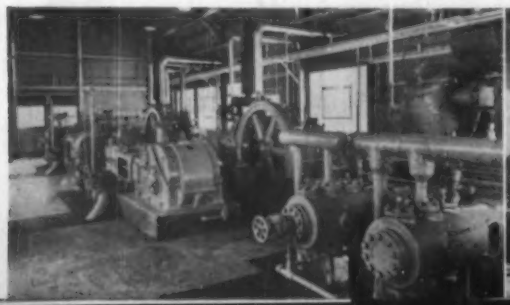
Design capacity is 60 million cubic feet of gas per day. Residue gas is dehydrated for pipeline sales. Approximately 2500 barrels of liquid products—propane, natural gasoline, and distillate—are recovered daily from the wet gas by means of high pressure absorption. Natural gasoline and distillate is carried by pipeline to the company's Houston refinery, the propane to railroad tank car loading facilities at Sheridan.

In the illustrations, the view at the upper left shows the absorption and distillation areas of the plant. Process piping, all located above grade on concrete or steel supports, is much in evidence. A gas-engine-alternator installation is shown at the left center. These machines supply power for pump drives, lighting, and other plant needs. They have a capacity of 750 kilowatts. Shown at the lower left are the plant's lean oil pumps which are steam-engine-driven reciprocating type. In the foreground is a gas compressor used in process service. In the lower right are to be seen the plant's steam boilers which have a total rating of 26,000 pounds per hour of steam delivered at 300 psig. Also shown are the plant's process heat furnaces.



Gas-Engine-Alternator Installation

Lean Oil Pumps



Plant's Steam Boilers

Precise Fractional Distillation Analysis

Part I. Theoretical Investigation of Low-Temperature Fractional Analysis Apparatus and Methods

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Podbielniak, Inc., Chicago

THE SATISFACTORY operation of light hydrocarbon processing plants is closely related to the convenience and accuracy of the means available for analyzing the compositions of the various charge, product, and intermediate process streams. This article explains some of the factors that influence the choice of methods and equipment for gas analysis by low temperature fractional distillation. Published here for the first time, it was presented some years ago before a meeting of the Petroleum Division of the American Chemical Society at Atlantic City. The article should be useful to many plant men since it includes both a discussion of theoretical considerations for analysis by low-temperature fractional distillation, and charts for the users of such apparatus.

A second article dealing with the practical operation of this type of analysis equipment will appear in the May issue of Petroleum Refiner.

IN AN earlier publication[1] the author presented his development of an apparatus and method for the analysis of gaseous and volatile liquid mixtures into their individual chemical components by means of fractional distillation at low temperatures in an efficient vacuum-jacketed column and accessory apparatus. Later papers[2, 3, 4, 5] describe improvements of both apparatus and method.

This present article discusses the findings of a theoretical investigation of which the immediate purpose was the best use of new high-efficiency columns and automatic control mechanisms developed, but which also has general application to low-temperature fractionation analysis.

The development of high-efficiency (from 50 to 100 and more plates) low-temperature fractionating columns has made possible the sharp analytical fractionation of propylene from propane, of iso-butane from iso-butene, of butene-1 from n-butane, and other difficult separations, requiring however very close control of column conditions, namely heat input, distillate rate (variable with composition, size of sample, stage of distillation, etc.) column temperature gradient, and method of application of still heat and reflux cooling.

Close control of column conditions is necessary in all low-temperature analytical work, even where separations are easy, as of methane from ethane, propane from iso-butane, etc., in order to secure desired accuracy of results in least distillation time. To date it has been possible to express the analytical procedure only in general qualitative terms, leaving it to the operator's experience to fix the actual distillate rates, heat, input, etc., for specific samples and analytical requirements. There has been a growing activity within the petroleum industry in the direction of standardizing low-temperature analysis procedures and establishing limiting apparatus specifications for interlaboratory use on specific sample types to meet specific analytical requirements. All this work has, however, been seriously hampered due to lack of at least approximately quanitative fundamental understanding of the analytical method considered as distillation process. The

TABLE I

Ease of Separation by Distillation of the Low-Boiling Hydrocarbons of Various Volatility Ratios ("Alphas") Measured by Minimum Plates and Minimum Reflux Ratio Required for Stated Concentration Changes.

NOTE: Values of "alpha" given below are approximate only, arbitrarily averaged for boiling point difference. Vapor pressure data taken from (a) "Physical Constants of Hydrocarbons" Vol. 1, by Egloff; (b) "Einfache und Fraktionierte Distillation in Theorie und Praxis" by Rechenberg and (c) personal communications to author.

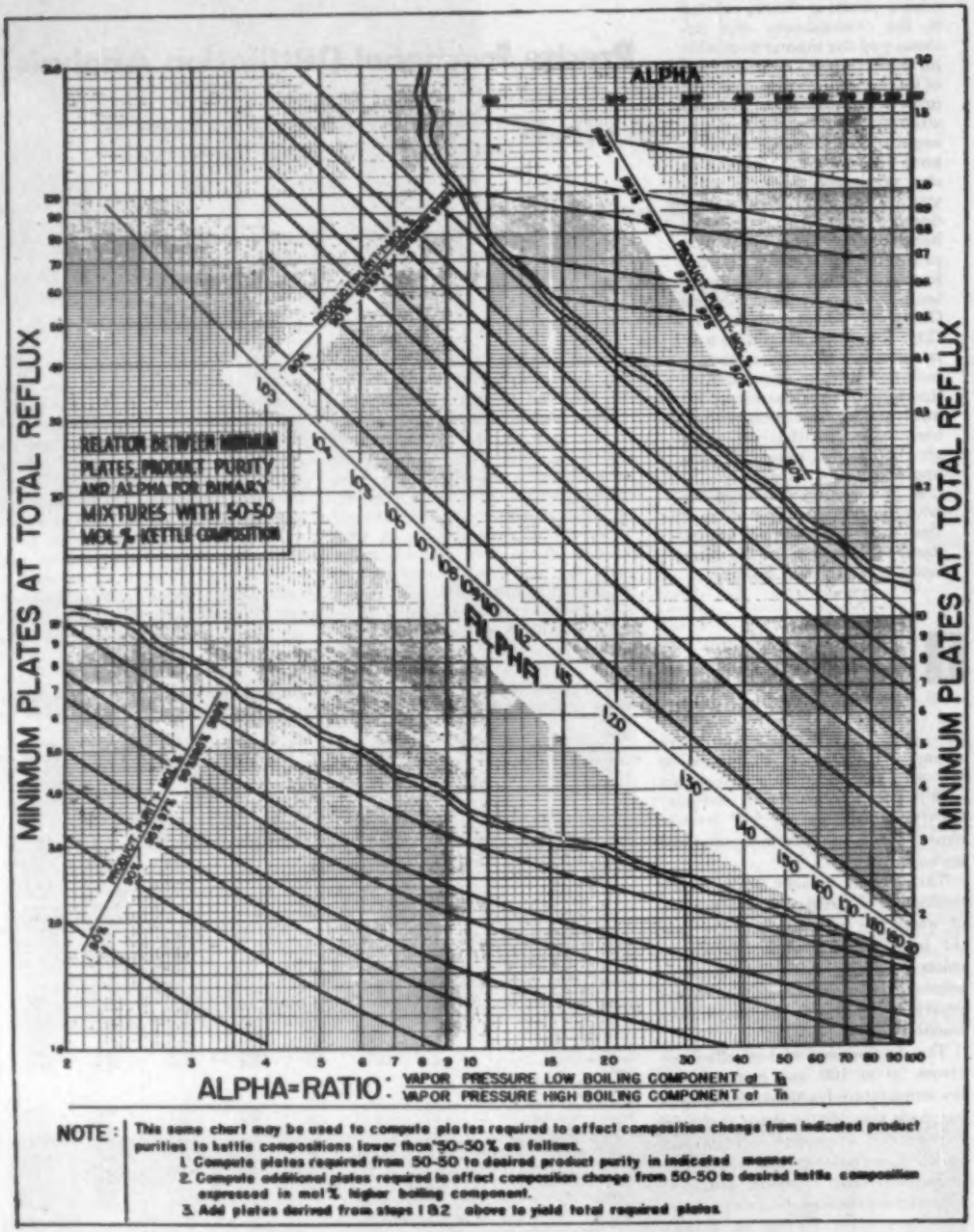
Binary Hydrocarbon Mixture	Boiling Point at 760 mm.		Ratio of Vapor Pressure "Alpha" at Midway B.P. of Two Components	Plates Required at Total Reflux For 99.5 mol. % Overhead From 50—50% Kettle Composition	Plates Required at Total Reflux For 99.5 mol. % Overhead From 10% Low Boiling Component in Kettle	Minimum Reflux Ratio For 100 mol. %* Overhead From 50—50% Kettle Composition	Minimum Reflux Ratio For 100 mol. %* Overhead From 10% Low Boiling Component in Kettle
Methane-Ethylene†	(—161.4	(—103.9)	61.2	1.23	1.93	0.08	0.164
Methane-Ethane†	(—161.4	(—89.5)	107	1.14	1.60	0.018	0.068
Ethylene-Ethane	(—103.9	(—89.5)	2.3	6.5	9.2	1.60	7.95
Ethane-Propene	(—89.3	(—47.7)	8.1	2.53	3.57	0.37	1.4
Ethane-Propane	(—89.3	(—44.1)	9.3	2.38	3.36	0.23	1.2
Propene-Propane	(—47.7	(—44.1)	1.3	20.2	26.6	6.65	33.0
Propane-Iso-Butane	(—44.1	(—13.4)	3.3	4.6	6.5	0.80	4.5
Iso-Butane-N-Butane	(—11.7	(—0.5)	1.5	13.0	18.4	3.90	20.0
Iso-Butane-Iso-Butene	(—11.7	(—6.7)	1.20	28.8	40.8	10.0	50.0
Iso-Butene-Butene-1	(—6.7	(—6.3)	1.08	176.0	249.0	65.5	328.0
Butene-1—Butadiene-1,3	(—6.3	(—4.5)	1.06	108.0	153.0	39.0	198.0
Butadiene-1,3 and CBM (Butadiene-1,3—79.5 mol. % (N-Butane 20.5 mol. %	(—4.5	(—5.1)	1.02	370.0	478.0	97.0	490.0
Butadiene-1,3—N-Butane	(—4.5	(—0.5	1.14	40.0	57.0	14.0	71.0
Butene-1—N-Butane	(—6.3	(—0.5	1.23	25.5	36.0	8.96	43.5
N-Butane—Trans-Butene-2	(—0.5	(+0.9	1.04	133.0	188.0	49.0	248.0
N-Butane—Cis-Butene-2	(—0.5	(+3.7	1.15	38.0	53.8	13.2	66.0
Trans-Butene-2—Cis-Butene-2	(+0.9	(+3.7	1.09	62.0	87.8	22.0	110.0
N-Butane-Iso-Pentane	(—0.5	(27.95)	2.8	5.3	7.5	1.16	5.8
Iso-Pentane-N-Pentane	(27.95)	(36.06)	1.33	18.6	26.3	0.25	20.1
N-Pentane-N-Hexane	(36.06)	(69.0)	3.0	4.9	6.95	1.04	5.25
N-Pentane-Diisopropyl	(36.06)	(58.1)	2.15	7.0	9.9	1.75	8.7

* Minimum Reflux Ratio (at infinite plates) is relatively insensitive to small changes in desired overhead purity especially for low "alphas" and small concentrations of low boiling components in kettle.

† Alpha at B. P. of methane=188.

‡ Alpha at B. P. of methane=642.

NOTE: The above computed values of minimum plates and of minimum reflux ratio, respectively, may be multiplied by 1.5 as an empirical practical rule to convert to the values required in actual distillation, which latter, of course, is conducted neither at total reflux nor with an infinite plate number column.



NOTE: This same chart may be used to compute plates required to effect composition change from indicated product purities to kettle compositions lower than 50-50% as follows.

1. Compute plates required from 50-50 to desired product purity in indicated manner.
2. Compute additional plates required to effect composition change from 50-50 to desired kettle composition expressed in mol % higher boiling component.
3. Add plates derived from steps 1 & 2 above to yield total required plates.

Figure 1. Minimum Plates at Total Reflux vs. Alpha

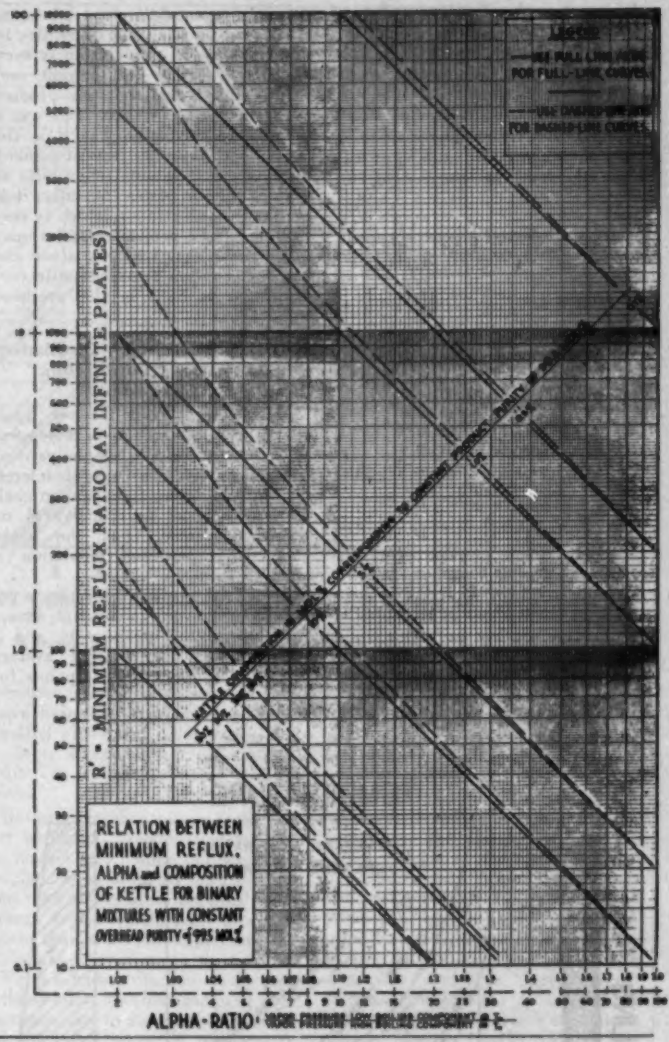
excellent theoretical investigations of analytical batch distillation by Rose et al.[6,7] while helpful to general understanding, are based on *constant* reflux ratios; whereas low-temperature analysis is based on *variable* reflux ratios, to maintain *constant product purity*. Also, in low-temperature analysis, it is desired to have specific solutions, in terms of specific separations, samples, distillate rates, etc., in order to be of real service in difficult applications and standardization work.

Minimum Plate and Minimum Reflux Ratio Requirements

The analytical distillation of wide-boiling components such as methane from ethane, propane from butanes, butane from pentanes, requires only a few theoretical plates and low reflux ratios; thus very sharp separations, as indicated by small intermediate fractions, have been readily accomplished with the simple wire coil packing and with a wide range of fairly high distillate rates.

However, the accurate separation of iso-butane from n-butane, and of iso-pentane from n-pentane, is of a higher order of difficulty, requiring much higher reflux ratios and proportionately lower distillate rates, and exacting more actual fractionating plates, for satisfactory reduction of intermediate fraction size, than are provided by the simple wire coil packing. The quantitative separation of iso-butane from iso-butene, or of butene-1 from n-butane, or of propylene from propane is not possible (except approximately) at all with the simple wire coil packing, and it further requires adequate time to come to equilibrium after entering sample, exact control of heat input to use column packing within its optimum operating range as to plates and holdup, and systematic variation of distillate rates to obtain required separation without excessive distillation time.

In order to help visualize the entire problem, and to provide at least limiting or basic data for further theoretical study, charts have been prepared, as shown in Figures 1 and 2, computed from the usual fundamental equations of fractional distillation theory, giving the minimum plates (at total reflux) and the minimum reflux (at infinite plates) for a complete range of column top and bottom concentrations and for varying "alpha" or ratio of vapor pressures of the two components of the binary mixtures to be separated. Incidentally, these charts have been found to be very convenient for approximate graphic solutions, using suitable correction factors to arrive at operating plates and reflux ratios of many distillation problems other than those of low-temperature fractionating analysis.


R' = MINIMUM REFLUX RATIO (AT INFINITE PLATES)
ALPHA - RATIO
RELATION BETWEEN MINIMUM REFLUX, ALPHA and COMPOSITION OF KETTLE FOR BINARY MIXTURES WITH CONSTANT OVERHEAD PURITY of 99.5 MOL %

NOTE: Minimum Reflux is relatively insensitive to small changes in product purity even when these are near 100%. To compute the approximate change in Minimum Reflux for other product purities than 99.5 mol % multiply Minimum Reflux, as obtained from chart, by the ratio of desired product purity to 99.5 mol %, times a Correction Factor varying as follows: a) 0.80 for 50% in kettle, b) 0.90 for 30% in kettle; c) 0.965 for 5% in kettle, and d) 0.990 for 0.1% in kettle.

Figure 2. Minimum Reflux Ratio (at Infinite Plates) vs. Alpha

The minimum plates chart was computed from the basic equation, No. 1:

$$N = \left(\frac{1}{\log 10\alpha}\right)\left[\log_{10}\left(\frac{X_p}{1-X_p}\right) - \left(\log_{10}\frac{X_t}{1-X_t}\right)\right]$$

where

N = minimum plates required at total reflux

α = ratio of vapor pressure of lower boiling component to vapor pressure of higher boiling component, at their midway boiling point.

X_p = mol fraction lower boiling component present in distillate.

X_t = mol fraction higher boiling component present in kettle.

It shows graphically the rapidly accelerating plate requirement with increase in required purity and with decrease of *alpha*. The assumptions of this chart are those of the well-known formula used for its computation, hence need not be here discussed.

The minimum reflux ratio chart was computed from the basic equation, No. 2:

$$R = e\left[\frac{1}{1-X_t} + f\left(\frac{1}{Xf\,(1-X_t)}\right)\right]$$

where

R = minimum reflux ratio at infinite plates.

X_t = mol fraction lower boiling component present in kettle.

$$e = X_p - \frac{\alpha}{\alpha - 1}$$

$$f = \frac{X_p}{\alpha - 1}$$

X_p = mol fraction lower boiling component present in distillate.

α = Ratio of vapor pressure of lower boiling component to vapor pressure of higher boiling component, at their midway boiling point.

Because the number of variables in this equation was one more than could be plotted in the chart, overhead purity was fixed at 99.5 mol percent. As noted at bottom of the chart, minimum reflux ratio is relatively insensitive to small changes in product purity even when this is near 100 percent, and varies almost linearly with product purity, as stated in chart. This was a surprise to the author, as it is the usual belief that 100 percent product purity requires infinite reflux ratio as well as infinite plates. Actually, it is the kettle concentration which is controlling. High product purities may be obtained, even with low *alpha* and low reflux ratios provided kettle concentration is high in the overhead component.

Ease of Separation by Distillation of Various Low-Boiling Hydrocarbons

Having prepared the two basis charts just discussed, the next step was to compute the *alphas* for the pairs of low-boiling hydrocarbons of interest in low-temperature fractionation analysis, as well as their analytical requirements, read from the *alpha* charts. The resulting tabulation is given in Table 1.

As is well appreciated, *alpha* is not even approximately a constant, except for close-boiling components, and it was necessary to compute average *alphas* at temperature mid-points for each pair of hydrocarbons, furthermore, the resulting *alpha* values are affected by errors which may be present in the available vapor pressure data which had to be used, and are to be used with these reservations in mind. In any case, it is far better to have closely approximated quantitative *alpha* factors, than just a boiling point difference which is not necessarily proportional to *alpha* as measuring ease of difficulty of separation.

In examining Table 1, it will be noted that only from one to two plates are required, ideally, to separate methane from ethylene or ethane. Actually, the separation takes place almost entirely in the reflux cooling section, and is a function more of hold-up in this section and of reflux section design and operation than of column packing characteristics. Probably not more than five theoretical plates will make possible the use of reflux ratios approaching the ideal values given in the table for methane and ethylene or ethane.

In examining the other separations, it should be kept in mind that at least double the minimum plates should be available for actual operation to take care of finite reflux ratios approaching minimum raflux ratios and to allow for effect of column holdup. Similarly, the minimum reflux ratio values of the table should be at least doubled to allow for reduction from infinite to actual plates. This point will be further discussed later in this paper.

Note the high number of plates necessary to separate iso-butane from n-butane with 10 percent iso-butane in kettle, namely 18.4 plates. Doubled, this becomes 36.8 plates, whereas the simple wire coil packing has been tested to usually not more than 15 to 18 theoretical plates, using the n-heptane and methylcyclohexane mixture. However, the values of the table are based on 99.5 percent product purity; if we assume that only 18 plates are available in packing, and divide the 18 by 2 to yield 9 plates (thus correcting for finite reflux ratio) than from chart in Figure 1, we obtain approximately 90 percent obtainable overhead purity. The choice of column packing will depend on desired maximum accuracy as expressed in desired overhead product purity.

The separation of iso-butane from iso-butene is interesting in that the ideal plate requirement steps up to 40.8 with 10 percent iso-butane in the kettle; times the arbitrary correction factor of 2, this means that a packing of at least 81 theoretical plates, under

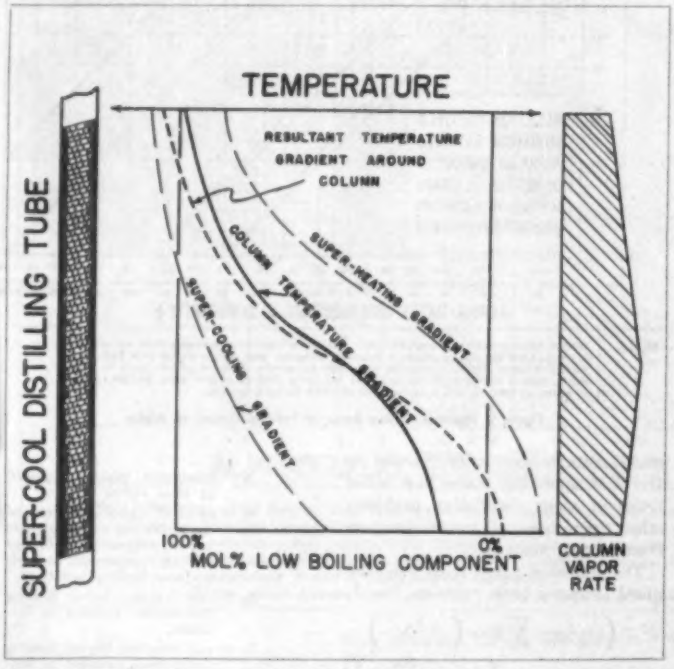


Figure 3. Thermal Conditions in Super-Cool Column with "Stretched" Temperature Gradient.

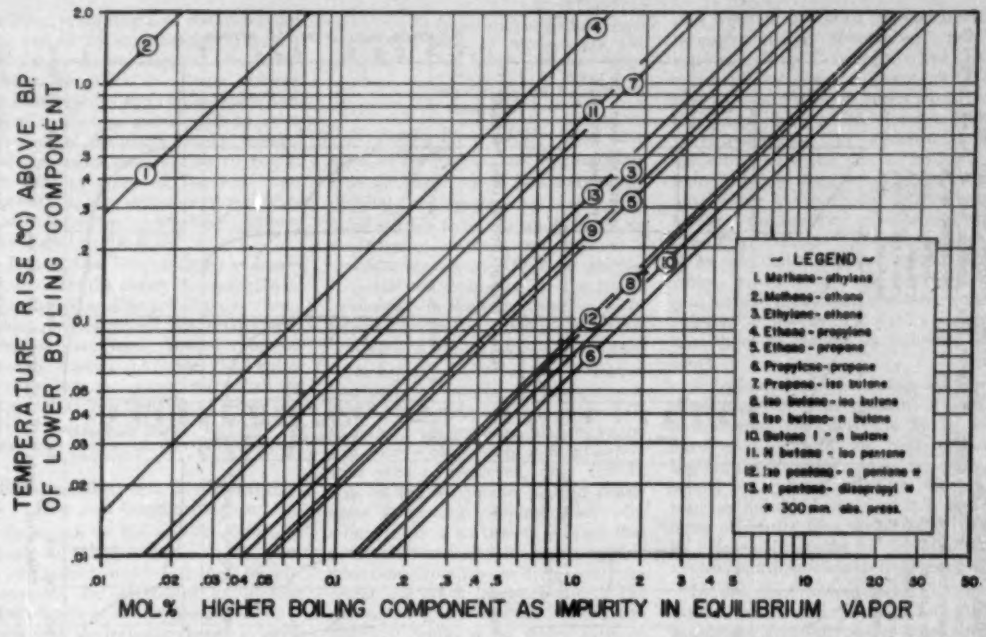

TEMPERATURE RISE (°C) ABOVE B.P. OF LOWER BOILING COMPONENT
MOL % HIGHER BOILING COMPONENT AS IMPURITY IN EQUILIBRIUM VAPOR
— LEGEND —
1. Methane - ethylene
2. Methane - ethane
3. Ethylene - ethane
4. Ethane - propylene
5. Ethane - propane
6. Propylene - propane
7. Propane - iso butane
8. Iso butane - iso butene
9. Iso butane - n butane
10. Butene 1 - n butene
11. N butane - iso pentane
12. Iso pentane - n pentane *
13. N pentane - dimethyl *
* 300 mm. abs. press.

Figure 4. Relations Between Rise from True B.P. of Hydrocarbon and Contamination of Its Equilibrium Vapor with Higher Boiling Component.

its operating conditions, is required to yield the desired separation. Low-Temperature packings testing up to 75 and 100 plates have been developed and described by the author in the previous paper[5] of this series. By the same reasoning, the separation by distillation of iso-butane from butene-1 is seen to require a packing of about 500 plates, and is therefore practically impossible at this time.

Further discussion of this table is unnecessary since a more complete graphic chart will later be presented showing the whole computed course of distillation of typical hydrocarbon samples.

Column Thermal Gradient Control

There may be some criticism of the use of ideal minimum plates and minimum reflux ratios in deriving conclusions and in fixing specific distillate rates, etc. One answer to this criticism is that using even the crudest correction factors for non-ideality, such as the factor of 2 thus far used, the resulting error is probably not more than 50 percent, whereas, at present our distillate rates are fixed entirely empirically and may be in some cases several hundred percent out of line from either the necessary or desirable values. Thus, the charts submitted are of value both in definitely fixing the minimum values of required plates and reflux ratios, and in giving a reasonably close approximation of actual operating requirements.

However, another answer is the fact that an actual fractionating column has neither zero holdup nor zero thermal lag, as assumed in the computations used above. Since the distillation process used is batch, there is a continuous change of both temperature and concentration gradient in the column.

We thus have a reaction on the part of the column towards change of concentration due to its material holdup, and towards change of temperature gradient, due to the heat capacity inertia of the column holdup and of the column itself and immediate surroundings. These reactions are not provided for in any distillation calculations that have been published, and may introduce a source of error roughly at least equal to 100 percent of the minimum reflux ratio values here computed. The only way to allow for the effect of these reactions is by experiment, using the ideal values as reference data.

However, out of this line of thought, and on the basis of comprehensive experimental work on non-adiabatic columns, as will be reported in part in the next paper of this series, a method of column conditions control has been developed and tested, which can be used to substantially offset the material and thermal capacities and lags of the column, thus securing an approach to the mathematically ideal conditions. The diagram of Figure 3 shows wherein by the combination of a "super-cooling" thermal gradient around the column (as is secured by permitting spent liquid air vapors from the reflux to course downwardly around the column, during one part of a cycle) and of a "super-heating" thermal gradient (as is secured by blowing warm air upwards around the column, during another part of the cycle) a "crossed" temperature gradient is obtained around the outside of the column. The peculiarity and advantage of this crossed temperature gradient is the fact that it makes possible the accentuation at every point of the normal or adiabatic column gradient, in the direction of the greatest fractionating effect. True, there is a price to pay for this in an increased reflux ratio requirement, however, experimentally it appears that it is a little price to pay for substantial improvement in fractionation.

What is pertinent in the present connection is also the fact that by suitably controlling the absolute and

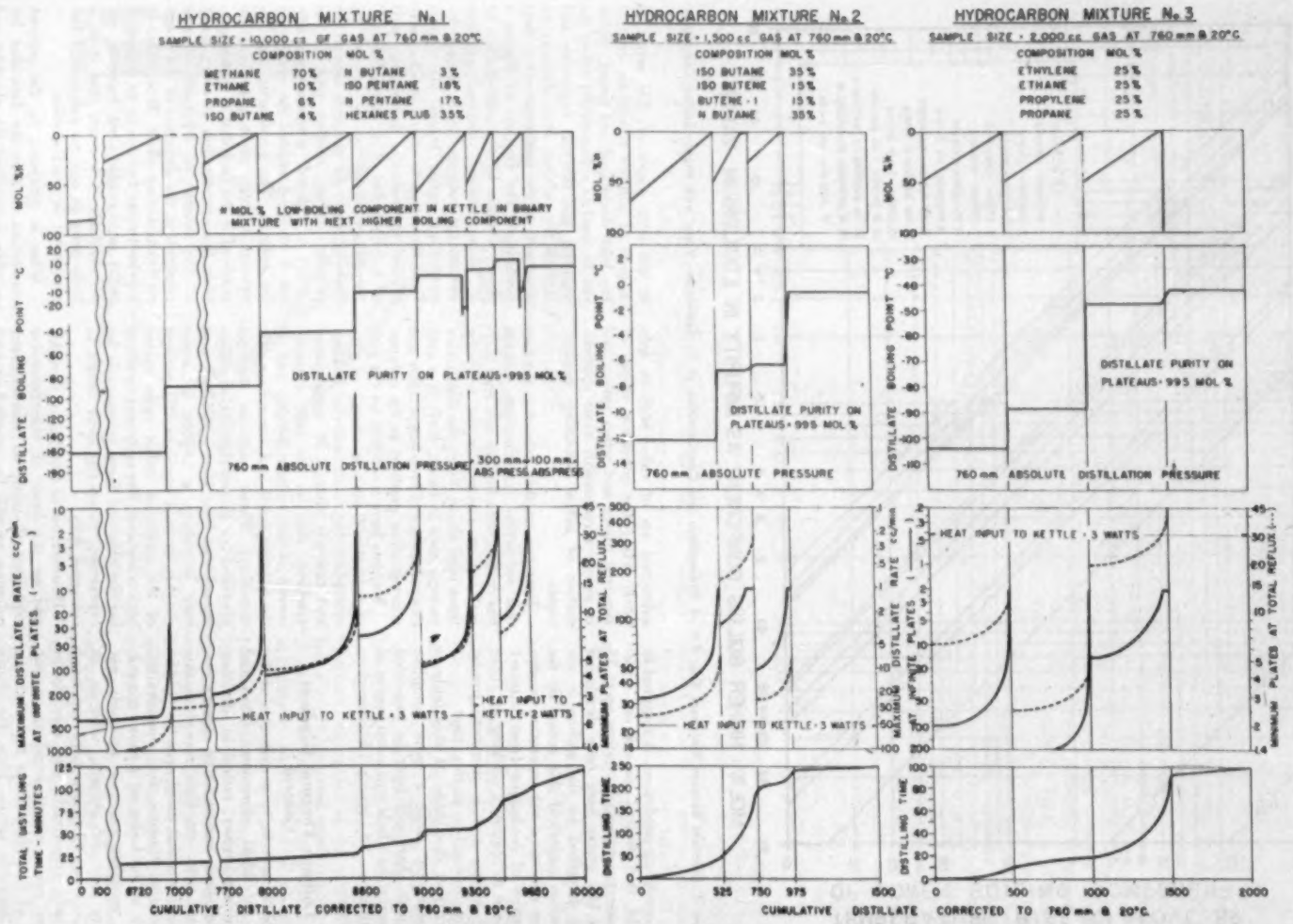

HYDROCARBON MIXTURE No. 1
SAMPLE SIZE = 10,000 cc OF GAS AT 760 mm & 20°C
COMPOSITION MOL %
METHANE 70%
ETHANE 10%
PROPANE 6%
ISO BUTANE 4%
N BUTANE 3%
ISO PENTANE 1.8%
N PENTANE 1.7%
HEXANES PLUS 3.5%
* MOL % LOW-BOILING COMPONENT IN KETTLE IN BINARY MIXTURE WITH NEXT HIGHER BOILING COMPONENT
DISTILLATE PURITY ON PLATEAUS = 99.5 MOL %
760 mm ABSOLUTE DISTILLATION PRESSURE
300 mm ABS PRESS
100 mm ABS PRESS
HEAT INPUT TO KETTLE = 3 WATTS
HEAT INPUT TO KETTLE = 2 WATTS
CUMULATIVE DISTILLATE CORRECTED TO 760 mm & 20°C.
HYDROCARBON MIXTURE No. 2
SAMPLE SIZE = 1,500 cc GAS AT 760 mm & 20°C
COMPOSITION MOL %
ISO BUTANE 35%
ISO BUTENE 15%
BUTENE-1 15%
N BUTANE 35%
DISTILLATE PURITY ON PLATEAUS = 99.5 MOL %
760 mm ABSOLUTE PRESSURE
HEAT INPUT TO KETTLE = 3 WATTS
CUMULATIVE DISTILLATE CORRECTED TO 760 mm & 20°C.
HYDROCARBON MIXTURE No. 3
SAMPLE SIZE = 2,000 cc GAS AT 760 mm & 20°C
COMPOSITION MOL %
ETHYLENE 25%
ETHANE 25%
PROPYLENE 25%
PROPANE 25%
DISTILLATE PURITY ON PLATEAUS = 99.5 MOL %
760 mm ABSOLUTE DISTILLATION PRESSURE
HEAT INPUT TO KETTLE = 3 WATTS
CUMULATIVE DISTILLATE CORRECTED TO 760 mm & 20°C.

Figure 5. Computed Low Temperature Fractional Distillation Curves, Required Distillation Rates at Infinite Plates, Required Minimum Plates at Total Reflux and Total Distillation Times.

relative proportions of the supercooling and of the superheating air, using column pressure response as control means, the effect of column material and thermal holdup can be quite completely offset as manifested by minimization of the usual wait at "breaks" for the reflux temperature to rise to the boiling point of the next component. It also becomes possible to distill residues completely without any liquid in the still.

It would be interesting to endeavor to work out the theory of what goes on in a packed or differential type column under such impressed abnormally steep gradient conditions, however, in this case the experiment proves to be easier and perhaps more conclusive than the explanatory mathematics. Present theory of batch distillation does not appear to account for this phenomenon.

Relation Between Temperature Rise and Contamination

Inasmuch as the computations and charts of this paper deal with overhead product purities, it soon became necessary, for successful application of the findings of this investigation, to work out the relation between overhead product purity and reflux temperature, as usually measured. Accordingly, an equation was formulated to compute the contamination of the *equilibrium vapor* of a nearly pure hydrocarbon with the next higher boiling hydrocarbon, as a function of rise of temperature above the true boiling point of the predominant hydrocarbon.

The basic equation, No. 3, used is as follows:

$$(1-X)\left[VP_1 + T\,\frac{dp_1}{dt}\right] + \left[X\left(VP_2 + T\,\frac{dp_2}{dt}\right)\right] = 760$$

where

X = mol fraction higher boiling component in distillate as liquid.

$1-X$ = mol fraction lower boiling component in distillate as liquid.

VP_1 = vapor pressure of lower boiling component in system (usually 760 mm).

VP_2 = vapor pressure of higher boiling component in system at same temp. as VP_1.

T = Boiling point rise of lower boiling component due to contamination of distillate higher boiling component.

$\frac{dp_1}{dt}$ = vapor pressure change per unit of temperature rise for lower boiling component at B.P. corresponding to 760 mm.

$\frac{dp_2}{dt}$ = vapor pressure change per unit of temperature rise for lighter boiling component at B.P. of lower boiling component corresponding to 760 mm.

It should be carefully noted that since in low-temperature fractionation, it is the *vapor* which is withdrawn as distillate, the equation has been formulated on this basis. As an example, in the case of methane and ethane, it makes a very great difference whether it is the contamination of the liquid condensate in the reflux section, *or of its equilibrium vapor* that is considered.

Figure 4 shows the chart plotted from Equation (3) for the hydrocarbon pairs of interest in low-temperature fractionation analysis. Even 2.0° C. rise on the methane plateau represents only 0.02 percent contamination with ethane. However, only 0.2° C. rise on the iso-butane plateau represents 1 percent contamination with n-butane. It is surprising to find that such small and usually imperceptible deviations from true boiling point represent so much contamination. The immediate application of this chart to practical work is to make sure of close column pressure control, and to use a temperature indicator accurate to at least 0.2° C., and preferably more accurate, if possible.

Computed Low-Temperature Fractional Distillation Curves, Required Distillation Rates at Infinite Plates, Required Minimum Plates at Total Reflux and Total Distillation Times

The master chart, Figure 5, correlates all the basic information of the previously presented charts in specific application to three illustrative hydrocarbon mixtures: 1) a typical natural gas; 2) a typical cracked C-4 fraction, the analysis of which has now become important as routine control of many alkylation plants, and 3) a special mixture of cracked C-2 and C-3 hydrocarbons. Not only are the analyses typical and specific, but the *volumes* of sample chosen are specific rather than on a percentage basis inasmuch as it will be shown that the size of the intermediate fraction, other things being equal, and neglecting column holdup, is directly proportional to the absolute volume of the sample. In other words, the smaller the sample the sharper the break! The master chart is therefore plotted against cc's of gaseous distillate and *not* against mol percent.

Basic in low-temperature fractionation procedure is the endeavor to obtain constant overhead product purity through suitable increase of reflux ratio as a "break" is approached. The entire master chart is based on 99.5 mol percent overhead purity except at the actual intermediate fractions between plateaus. The assumption is made that only one pair of hydrocarbons is being distilled at a time, the next higher hydrocarbons assumed not to affect the resulting calculations appreciably. Column holdup is assumed to be zero. Instead of minimum reflux ratios, it has been more desirable to plot actual *maximum distillate rates* referred to 3 watts or 2 watts constant heat input to column as indicated in chart.

It follows from the above assumptions, that the mol percent of each hydrocarbon considered to be in binary mixture with the next higher boiling hydrocarbon may be represented by a straight line on the plateau, as indicated in chart. It is to be noted carefully that the *slope* of this line depends directly on the *absolute volume of the next higher hydrocarbon.*

In the third lowest section of the master chart are plotted both the *maximum distillate rates* (computed directly from the minimum reflux ratios of the chart Figure 2, taking into account the stated heat input to column and known hydrocarbon physical constant factors) and the *minimum plates at total reflux.* It is interesting to note the substantial parallelism of these two values as a function of the mol percents in uppermost chart section. In order to avoid infinite values at breaks, the maximum distillate rate has been "cut off" at 30 cc. per minute for methane, and at 2 cc. per minute for the other "breaks" in mixture No. 1, and at somewhat lesser values for mixtures No. 2 and 3, as indicated in chart. Assuming the transition curve between two hydrocarbons to be closely symmetrical, the size of the intermediate fraction becomes double the number of cc. from cut-off point to the theoretical "break" line, and thus the distillation curves themselves, in the second lowest section of the master chart, have been drawn. The lowest section of the chart is derived by integration of the reciprocal of the maximum distillate rates (minutes per cc.) and represents the theoretical cumulative distillation time.

The master chart contains a great deal of useful comparative and absolute information, but its limitations must be very clearly understood and proper allowances made for them. The assumptions of zero holdup, total re-

flux (for computed plates), infinite plates (for computed reflux ratios) have already been stated. The present chart also implies that unlimited plates are available to meet the demand, even up to some 400 plates for the separation of butene-1 from iso-butene.

Actually, the simple wire coil packing tests only about 15 plates, while the Heli-Grid packing, as described in the previous paper of this series, can be constructed to test from 75 to 100 plates, when operating considerably below flooding point. It is necessary to consider the fractionating column and packing one has available or intends using and then use the present chart as a work sheet to derive new "cut-off" points corresponding more nearly to actually available column plates, with increased intermediate fractions. Also the holdup of the column should be known for various heat inputs, and considered in estimating intermediate fractions for various operating condition. Unless all important factors can be quantitatively evaluated and correlated, the present charts can be only of comparative rather than specific aid.

The number of interesting conclusions which may be drawn from the present study is so large that no attempt will be made here to be exhaustive.

The following may serve as illustrations:

(a) From the shape of the maximum distillate rate curves, it is obvious that any other method of varying distillate rate is bound to be either wasteful of time or resulting in loss of accuracy or both. In particular the method of constant reflux ratio, sometimes advocated, can lead to total distillation times of 26 or more hours with no more and probably less accuracy than the arbitrarily increased distillation time of about 3 hours, predicted from the chart for mixture No. 1. Actual distillation times in any case should vary from 2 hours to 5 hours, both from the study of this paper and from all experience: materially greater distillation times than this indicate improper variation of distillate rate or unnecessarily large samples.

(b) The size of the intermediate fraction between components varies almost directly as the absolute amount of higher boiling component following the break. This is a corollary of the fact that it is possible for Rose et al.,[6,7] to compute batch distillation curves on a mol percent basis; in other words, the intermediate fraction is a *percentage* of total sample size.

Thus we obtain an explanation of why in low-temperature analysis of *gases*, sharper breaks are obtained between iso-butane and n-butane, (although these may be present in quantities of only as little as 50 cc. vapor each than in a 50 liquid cc. sample of natural gasoline. For the same reflux ratios, a small sample will have intermediate fractions, which will be smaller than those of a large sample, but which will represent the same percentages of sample in each case; if effect of holdup is ignored. It is thus advisable to use small samples if maximum accuracy in least total distillation time is desired, as long as column holdup does not interfere unduly with above expressed relation.

(c) A large number of plates is helpful even in the easier separations. It must be appreciated that actually the column has an appreciable holdup and usually it is only part of the column that is operating on the intermediate fraction, hence the ideal values given by the chart may have to be multiplied by a factor of three or more to yield a close approach to the small intermediate fractions shown in the chart. There is also the time-saving effect of an excess of plates in bringing the column to equilibrium faster on a more difficult separation; it may take an hour or more to establish a proper column gradient on the separation of a trace of iso-butane from a large volume of n-butane.

(d) The purity of overhead product is inadequately indicated by the usual reflux temperature indicating system (not sensitive to temperature changes less than 0.2° C.) when distilling close-boiling components, such as iso-butane and n-butane, as is apparent from a study of the chart, Figure 4. Recent careful work on synthetic mixtures of iso-butane and n-butane of iso-butane, iso-butene, butene-1 and n-butane, has shown the need and usefulness for a more sensitive (to 0.05° C.) precision potentiometer system, for working out best operating conditions and for accurate determination of plateaus and cut-points. Coincidentally, distillation pressure must be controlled to within a millimeter of mercury or less and design of reflux cooling vessel must be suitable to secure true temperature readings.

(e) Using high-efficiency packings, such as the Heli-Grid packings described in the previous paper[5] of this series, coupled with carefully planned operating procedures, based on the theoretical study of this paper, it has been proven possible, both for research and for routine control purposes, to determine the iso-butane in a 2.5-97.5 percent synthetic, iso-butane-n-butane mixture within 0.2 percent accuracy, and to determine iso-butane from iso-butane and butene-1 from n-butane in a synthetic cracked C4 fraction with an accuracy of 1 percent or better by distillation alone. This constitutes experimental verification of the theoretical investigation reported in this paper, as well as establishing a sound basis for new application of the improved low-temperature fractionation apparatus and method.

(f) The importance of proper control of heat input to column, of proper variation of reflux ratio, proper time allowance for column to reach equilibrium, and of knowing what can and cannot be done with a given apparatus and analytical procedure, have been made apparent by this study, in a quantitative rather than just a qualitative manner.

LITERATURE CITED

[1] Podbielniak, I. E. C., Anal. Ed. 3, p. 177, (1931).
[2] Podbielniak, I. E. C., Anal. Ed. 5, p. 119, (1933).
[3] Podbielniak, I. E. C., Anal. Ed. 5, p. 125, (1933).
[4] Podbielniak, I. E. C., Anal. Ed. 5, p. 172, (1933).
[5] Podbielniak, I. E. C., Anal. Ed. 13, pp. 639-645, (1941).
[6] Rose, I. E. C., 32, p. 594, (1941).
[7] Rose and Long, I. E. C., 33, p. 684, (1941).

ACKNOWLEDGMENT

Grateful acknowledgment is made to Wladzia Podbielniak for assistance in preparation of this paper.

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The technical committee of the CNGA conducts, as may be deemed advisable from time to time by the executive committee, investigation and research toward the advancement and improvement of test and measurement procedures common to the industry; to promote such standardization which may be of common interest to members of the Association. The committee recommends to the executive committee for publication, such standards, bulletins, or revisions of bulletins as it may have developed. Bulletins on the subjects, for example, T.S. 501, define the scope and otherwise give general instructions as to what is needed by the industry in standardization and clarification. The technical committee is directed to investigate certain established methods of test and to limit research work only to minor changes in equipment and technique that will tend to give more consistent and duplicative results by the different operators.

Determination of

Carbon Dioxide And Oxygen In Natural Gases

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R. A. MONTAGUE, CNGA
Committeemen

CALIFORNIA Natural Gasoline Association's Bulletin TS-501 presents a tentative standard procedure for the determination of carbon dioxide and oxygen in natural gases. This bulletin is intended as an operating manual for the analyst in the laboratory and in the field. While the Orsat test has long been in use, there are many variations in apparatus and application. Consequently in this bulletin, CNGA has established a standard apparatus and procedure, describing the equipment, reagents and procedures in the laboratory and field for the determination of carbon dioxide and oxygen in natural gases.

Recognizing that the same degree of accuracy is not generally required for field work as in laboratory, two procedures are set forth; one, for permanent laboratory installation (Figure A) where accuracy is a prime consideration; and an alternate, for plant and field use (Figure B) where apparatus must be portable and rugged. Both procedures make use of the same general principle of absorption of carbon dioxide and oxygen in separate pipettes.

By careful manipulations for laboratory determination the results are accurate to ±0.1 percent of the burette volume, providing the composition of the sample is such that hydrocarbon dew point is not reached during the procedure. In the field determination such factors as change of composition through condensation of the sample, atmospheric conditions during the test, and the design of equipment will influence the accuracy of results obtained. However, careful manipulation of the apparatus should give accuracies within ±0.2 percent of burette volume.

The apparatus consists of a stopcock manifold to which are attached two or more absorption pipettes of the auto-bubbler or equivalent design and a water jacketed 100 ml burette graduated in 0.1 ml divisions. Mercury is used as the confining liquid in the burette and attached leveling device. Water is added to the burette to insure saturation of the gas sample, but the amount added should not produce a readable difference above the mercury meniscus. The burette is equipped with an ambient temperature compensator which will allow a volumetric reproducibility of ±0.05 ml over a range of 10° F. (Figure 1). Each pipette is attached to a manifold stopcock with a flexible connector. The pipette nearest the burette is normally used for the absorption of carbon dioxide. An additional sampling stopcock is used to admit the sample to the burette and for venting the residual sample (Figure 1).

The pipettes each consist of an absorption chamber and a reservoir. The

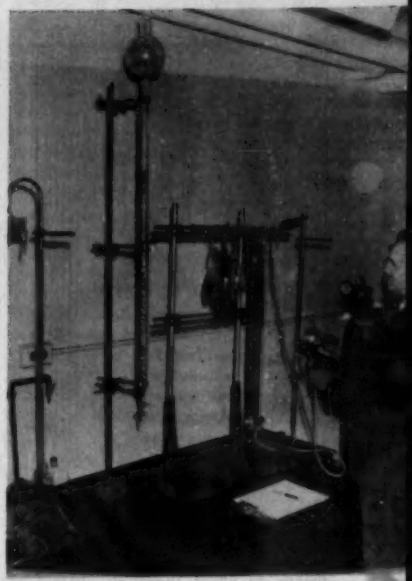
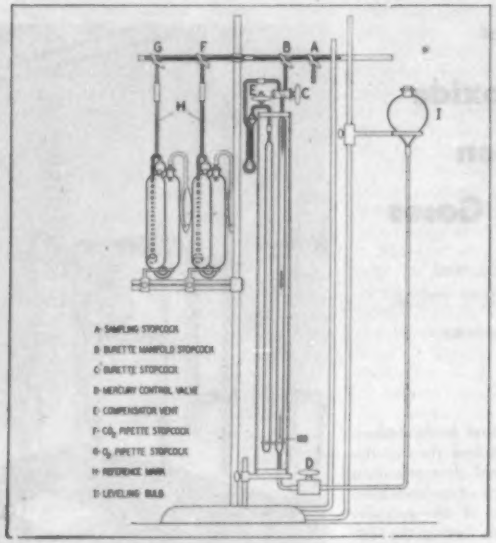
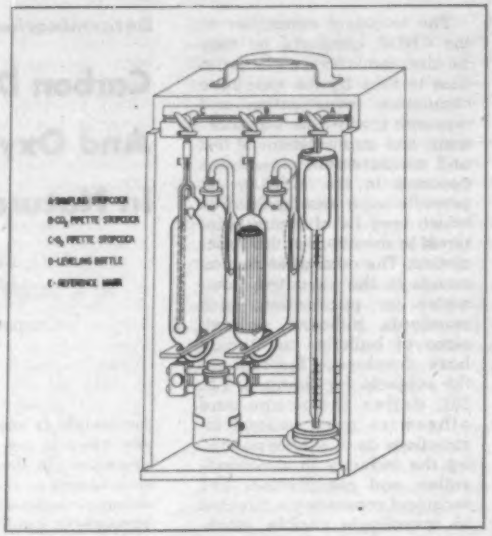


Figure A. Shows Laboratory Apparatus Described in CNGA Bulletin TS-501 for Orsat Analysis.

Figure B. Shows Field Apparatus Described in CNGA Bulletin TS-501 for Orsat Analysis.





absorption chamber provides suitable means to effect thorough contact of the sample with the reagent. The top of the reservoir of the oxygen pipette is connected to a rubber bag or water seal to prevent contact of the absorbent solution with the atmosphere. A similar connection may be used for the carbon dioxide pipette reservoir.

A suitable framework to support the parts mentioned completes the apparatus.

Basically the portable apparatus consists of a stopcock manifold to which are attached two absorption pipettes and a water jacketed burette equipped with a leveling bottle containing the confining liquid. The burette should be graduated in divisions of 0.1 or 0.2 percent of total burette volume. Each pipette and the burette are connected to a manifold stopcock with a short flexible connector. The pipette nearest the burette is used for the absorption of carbon dioxide. (Figure 2).

The pipettes each consist of an absorption chamber and a reservoir. The absorption chamber provides suitable means to effect thorough contact of the sample with the reagent. The top of the reservoir of the oxygen pipette is connected to a rubber expansion bag or water seal to prevent contact of the absorbent solution with the atmosphere. A similar connection may be used with the carbon dioxide pipette reservoir.

A portable framework to support the parts mentioned completes the apparatus.

Laboratory Determination: This method depends upon the absorption of carbon dioxide and oxygen in certain chemical solutions. A sample of the gas being tested is successively passed through absorbent solutions of potassium hydroxide and chromous chloride which specifically absorb carbon dioxide and oxygen from the sample, the reduction in volume resulting from each absorption is measured and the results calculated. A formula for this calculation is presented in the bulletin.

Field Determination: Basically the principle of absorption in the field is the same as in the laboratory except that the apparatus used is more compact and is designed for portability in the field.

Several other methods, including single determinations for either oxygen or carbon dioxide, are in use for special or specific purposes. There are also variations of the CNGA apparatus which are manufactured commercially. The limitation of accuracy for each type and its over-all acceptability was considered to be beyond the scope of this bulletin.

Figure 1. (Above, left). Laboratory Apparatus

Figure 2 (Above, right). Field Apparatus.

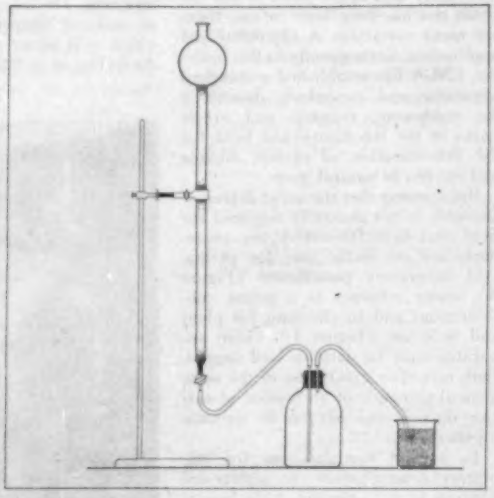


Figure 3. Jones Reductor

The Selection of Treating Processes for Gasoline Plants

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IT IS assumed here that the normal products of a gasoline plant are propane, butane and grade natural gasoline. The production of isobutane or special products, however, may have considerable effect on the over-all treating facilities and where planned, must be given proper consideration. The treatment of these products is almost exclusively confined to the removal of hydrogen sulfide and free sulfur and either the removal or conversion of any mercaptan sulfur which may be present. To accomplish this, a rather wide selection of processes is available and should be evaluated by the natural gasoline plant operator, who must also choose the proper location of these facilities in his processing sequence. When a new gasoline plant is to be built, the over-all treating requirements for the desired products and specifications are first considered; then, the process or processes necessary to meet these requirements with a minimum of investment and operating cost can usually be selected. In existing plants, however, as capacity additions are made or as problems requiring treating facilities arise, it is frequently necessary to utilize such facilities as may already be available or to add additional facilities as may be most easily or quickly installed. There are a number of well known and well established operations for handling all of the above sulfur compounds, any one of which may be preferable or most economical for a given treating problem, depending on conditions existing at the particular plant. This article reviews briefly the better known operations and their application and possibly contributes a few more or less new ideas.

THE development and extensive use of amine solutions and similar processes for removal of hydrogen sulfide from the inlet gas prior to absorption has greatly simplified the problem of handling hydrogen sulfide in the liquid products. Usually, however, in plants where hydrogen sulfide is present in the incoming gas, some treating facilities are still required to clean up the hydrogen sulfide which may not have been completely removed in the gas treating process and to protect against operational upsets in this equipment. Generally speaking, hydrogen sulfide should be removed as early as possible in the processing operations to protect against corrosion which always exists when hydrogen sulfide is present. However, in most cases, where the inlet gas is treated for hydrogen sulfide removal, any hydrogen sulfide remaining in the depropanizer feed is removed in the propane overhead product. Here, then, is the most convenient point to locate the additional treating facilities because of the relatively smaller volume and the consequent reduction in equipment required.

The most common means for removing hydrogen sulfide from liquids is the ordinary caustic wash. This operation is well adapted for handling propane or other products in which hydrogen sulfide may occur. The equipment required is extremely simple, consisting only of a settling tank from which the caustic is recirculated and means for mixing the caustic and hydrocarbon product. The mixing may be accomplished either by centrifugal pump, eductors or the ordinary spider whichever may best fit the conditions at hand. Ordinarily, elaborate mixing facilities are not required where only hydrogen sulfide is to be removed. The principal disadvantages of the caustic wash for hydrogen sulfide removal are the cost of the caustic soda and in many locations the increasing difficulty of satisfying the anti-pollution laws governing disposal of spent

caustic solution. It is best utilized, therefore, where the amount of hydrogen sulfide to be removed is not large and the chemical costs not excessive.

Where caustic consumption is high, resulting in a relatively high treating cost, some economy may be effected through the use of two-stage scrubbing. Where only a single stage scrubber is used, the caustic solution must be changed before it is completely spent to avoid break through of hydrogen sulfide; whereas, if a second stage is added almost theoretical caustic efficiency may be realized. The use of sand filters following the caustic wash is too frequently overlooked in this type of operation. Sand filters are particularly desirable to remove any traces of caustic carry-over where additional processing such as dehydrating or copper treating follows the caustic wash. In many cases the size of the caustic settling vessel may be reduced by following with a sand filter to remove carry-over which may result from reduced settling time.

Another means for removing hydrogen sulfide from liquid products is the use of amine solutions, which has only recently come into use and is not widely practiced. Although the hydrogen sulfide removal is not one hundred percent complete and a follow up caustic wash is still required, this process offers many advantages over the use of straight caustic washing. This is especially true where the amount of hydrogen sulfide to be removed is large or where an amine gas treater is already in operation and the existing regeneration facilities can be used for both the gas treating and liquid treating operations.

One suitable unit for treating liquid propane with diethanolamine solution includes scrubbing in a vertical tower packed with carbon raschig rings. The lean amine solution can be taken from a unit originally installed for gas treating.

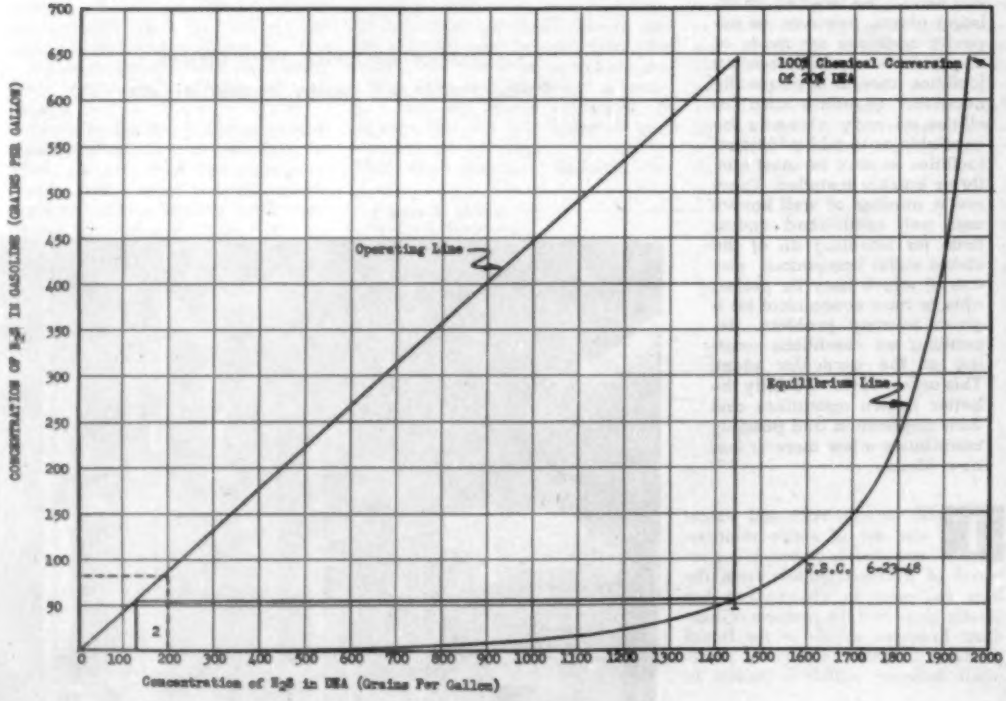
For those who may wish to consider amine treating facilities, Figure 1 shows a calculated curve for the absorption of hydrogen sulfide by diethanolamine, based on 100 percent conversion of a 20 percent DEA solution. Although this is a calculated curve, experimental data indicate it can be used in the design of absorption equipment. It is noted that a single stage contact is not quite sufficient although a second stage brings the removal below the accuracy of the curve. It appears that the amine scrub should be followed by a caustic wash to remove final traces of hydrogen sulfide.

Some use has been made of other gas treating processes (such as tripotassium phosphate) in the treatment of liquid products, but we have no information on these operations.

Free Sulfur

It is fortunate that free or elemental sulfur is not frequently encountered, since its removal from hydrocarbon products is in many cases one of the most difficult treating problems. It can be efficiently removed, though, by use of a caustic-polysulfide solution if the equipment is properly designed and operated. The equipment requirement is similar to that used in the ordinary caustic washing operation. Particular attention must be given to contacting of the polysulfide solution with the hydrocarbon. When the degree of mixing obtained in the usual jets, orifices and spiders is not sufficient, a centrifugal mixing pump is essential. A low-efficiency open-impeller

Figure 1. Absorption of H_2S by Diethanolamine Gasoline—DEA—Liquid Extraction



pump is preferable. A closed impeller pump has been used with good results although it is necessary to open up the clearance and operate at about 40 percent efficiency. As in the usual caustic scrubbing operation, the mixing pump takes suction on both the oil and the polysulfide solution discharging the mixture into the settling tank from which the polysulfide is recirculated. The fresh solution may be prepared by dissolving one pound of commercial (50-60 percent) sodium sulfide and 0.1 pounds of flowers of sulfur in each gallon of approximately 15° Baume caustic solution. It is important that the flowers of sulfur be completely dissolved; otherwise the gasoline will come from the treater more corrosive than it was originally. In removing free sulfur, the solution is most active at a polysulfide concentration of approximately $Na_2S_{2.5}$ and rapidly loses its affinity for elemental sulfur when the polysulfide concentration passes $Na_2S_{3.5-4.0}$. When the solution requires replacement, not more 80 percent of the polysulfide solution in the system should be discarded and the volume made up with fresh sodium sulfide-caustic solution. The old solution left in the system will "seed" the fresh caustic-sulfide solution making it unnecessary to add any flowers of sulfur to the new solution. Partially spent caustic, if available, may be utilized for making up the solutions. A ratio of approximately 60 percent hydrocarbon and 40 percent polysulfide solution should be maintained at the pump discharge for maximum sulfur removal efficiency.

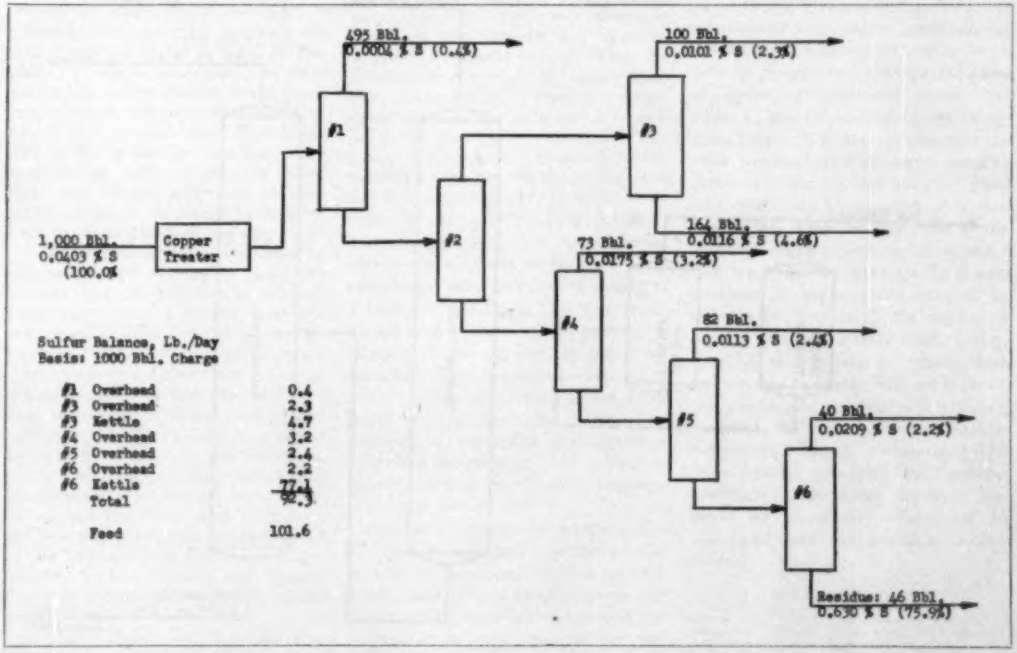
Where mercaptans are also present with free sulfur, it is possible to eliminate the sulfur by a wash with ordinary doctor solution, the free sulfur being consumed in converting the mercaptans to disulfides in the doctor sweetening reaction. The principal disadvantage of this operation is that if the amount of mercaptans present is more than required for the elemental sulfur present, additional sulfur must be added to obtain the doctor solution "break." This requires constant attention and frequently results in too much sulfur being added. Then the treated product is just as corrosive as before treating. The doctor solution must also be regenerated periodically. Free sulfur is usually found in kettle products and the best "treating method" is to avoid its formation which is almost always caused by air coming in contact with products containing hydrogen sulfide.

Mercaptan Sulfur

The processes for the treatment of gasoline containing mercaptan sulfur compounds fall generally into two classes, 1) those which remove the mercaptans from the gasoline thereby lowering the total sulfur content, and 2) the so-called sweetening processes in which the mercaptan sulfur is converted to the disulfide, which is odorless.

The first class, those processes which actually remove the mercaptan sulfur compounds, comprise either the ordinary regenerative type caustic wash or some modification thereof in which some agent is added to increase the solubility of mercaptans in the caustic. The latter modifications are not used extensively in the natural gasoline industry since the light or low molecular weight mercaptans normally found in natural gasoline are readily removed by the ordinary regenerative caustic wash and the addition of solutizing agents does not give sufficiently improved results to merit their use. The regenerative caustic wash has been described in the literature on numerous occasions and is familiar to most of you. Its principal advantage is the ability to handle products of extremely high mercaptan contents and

Figure 2. Fractionation of Copper-Sweetened Natural Gasoline.



to reduce the total sulfur content of treated products by the extent of the mercaptan sulfur removed. The latter factor is usually of importance only on LPG products or where the sulfur content of the natural gasoline is unusually high. The disadvantages of the regenerative caustic wash processes for the average treating load are the increased investment and operating costs when compared to sweetening processes.

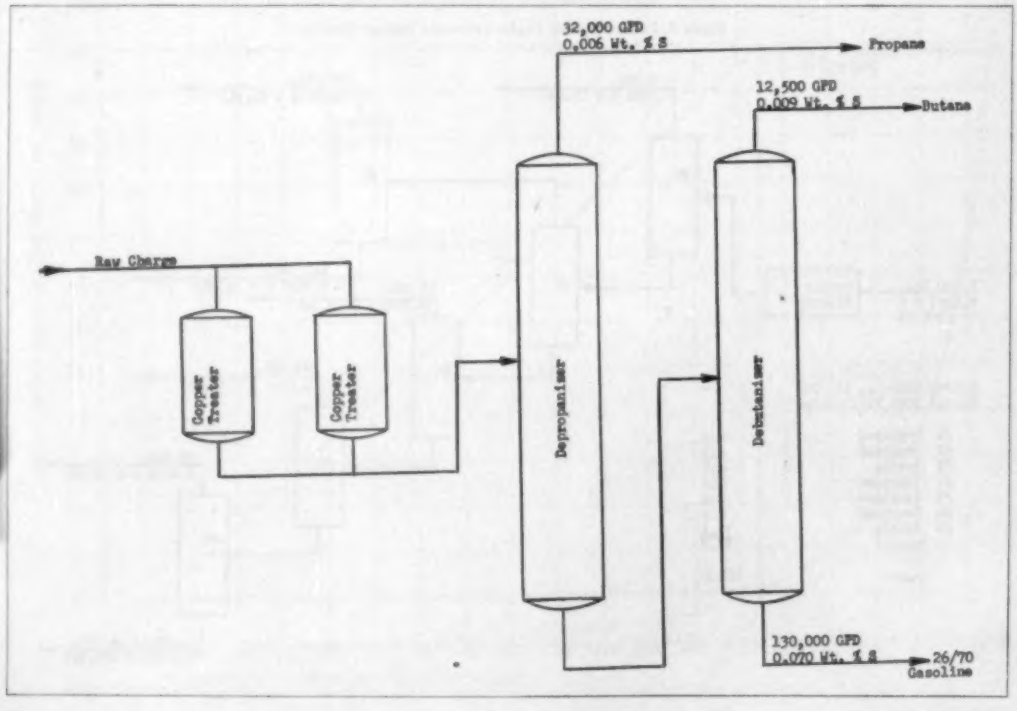
Also in those cases where the mercaptan content is such that the reduction in total sulfur achieved by a regenerative caustic wash would be an important factor, there may be sufficient other sulfur compounds present in the gasoline to justify consideration of catalytic desulfurization. Such processing of high sulfur natural gasoline to improve the TEL susceptibility may assume greater importance in the future as many refiners find increasing difficulty in meeting octane specifications. A regenerative caustic wash should preferably be installed ahead of the depropanizer or debutanizer, thereby eliminating the need for further treatment of the propane and butane LPG products. Where a completely doctor sweet grade natural gasoline is required, however, it is usually necessary to add facilities for sweetening this stream. When hydrogen sulfide is present in the feed to a regenerative caustic wash, it is necessary to install an ordinary caustic scrubber for its removal prior to the regenerative caustic treatment.

Several sweetening processes are available for the treatment of mercaptans in natural gasoline, including the doctor process, hypochlorite process and the copper sweetening processes. The copper sweetening process, and particularly, the solid treating modification, is most widely used in the natural gasoline industry and is familiar to all of you. The great advantage of this process over the regenerative caustic wash as well as other sweetening processes is the relatively minor investment required and the simplicity of the operation, resulting in a low treating cost per gallon. The principal limitation of the solid copper sweetening process, insofar as the natural gasoline industry is concerned, is the amount of mercaptan sulfur present in the feed which can be satisfactorily handled. Although units are in operation on stocks having in excess of 0.1 weight percent mercaptan sulfur, it is recommended for best operation that the feed be limited to a mercaptan sulfur content not exceeding 0.05 weight percent. Where the feed stocks will contain mercaptan sulfur in excess of that amount, we recommend that regenerative caustic wash facilities be installed to reduce the mercaptan sulfur to at least this amount prior to the sweetening operation.

The sweetening units may be located on the individual butane and natural gasoline streams or on the debutanizer feed or even the depropanizer feed although the latter is not usually recommended except in instances requiring special consideration. In most plants only the natural gasoline is sweetened, or the natural gasoline and butane streams are sweetened individually. There are appreciable advantages, however, in treating the combined streams that may not have been fully evaluated.

The disulfide sulfur compounds formed from any given mercaptan in the sweetening reaction always have a higher boiling point than the corresponding mercaptan. Since mercaptans are the only sulfur compounds, other than hydrogen sulfide, found in the lower boiling hydrocarbons, sweeten-

Figure 3. Copper Sweetening Prior to Fractionation.



ing prior to the separation of these lower boiling products converts the mercaptans into higher boiling compounds which will remain in the final kettle product, thereby eliminating the necessity for treating the overhead products and also producing an essentially sulfur free overhead material. This is best illustrated by the data shown in Figure 2. This figure illustrates part of the fractionation sequence in one of the Phillips plants where a natural gasoline stream is copper treated prior to fractionation. Figure 2 illustrates the fractionation sequence employed and also shows a material balance around the unit. The feed to the copper treater contains 0.04-0.05 weight percent total sulfur of which approximately 50 percent is mercaptan sulfur. The doctor-sweet product from the copper treater is charged to tower No. 1. Where half of the charge is removed as an overhead stream which has a total sulfur content of only 0.0004 weight percent. The kettle product from this column is further fractionated into five overhead products having total sulfur contents ranging from 0.0101 to 0.0209 weight percent and a final kettle product with a total sulfur content which may vary from 0.5-1.0 weight percent.

It will be noted that in this particular survey 76 percent of the total sulfur originally present was concentrated in a final kettle product representing less than 5 percent of the charge. In this particular study, the calculated total quantity of sulfur present in the products accounts for only 91 percent of that in the original feed. The difference is due to the fact that the sulfur analyses of each stream are taken from spot checks while the product ratios are based on monthly averages. Even so, these data indicate very forcibly the desulfurization which may be obtained from sweetening prior to product fractionation. While this example represents a rather extensive fractionation procedure, the same effect may be obtained in simpler operations. Copper sweetening prior to debutanization, for instance, will produce an essentially sulfur free butane overhead which requires no further treatment. Figure 3, for example, shows schematically the treating and fractionation employed in a West Texas gasoline plant. The solid copper sweetening units are located ahead of the depropanizer, thereby producing low sulfur propane and butane products requiring no further treatment.

In many plants, only propane and butane are produced as finished products and the grade natural gasoline production is moved through crude oil pipe lines where a sweet product is not necessary. In such cases, the butane only may be sweetened where the mercaptan content is not so large as to result in an excessive total sulfur content of the finished butane. If the mercaptan content of such streams is in excess of total sulfur specifications, then some type of caustic wash facilities will be required. The economics in these instances may sometimes justify a simpler treating system such as solid copper sweetening on the total butane and heavier production. In some plants, a satisfactory product has been obtained by copper sweetening the butane; subsequently, it is flashed or revaporized in order to leave the high boiling sulfur compounds in the flash drum.

Since most of you have copper sweetening facilities in your plants, it might be well to mention very briefly a few of the more special operating problems which may be encountered. The usual operating difficulty on these units is the accumulation of water in the sweetening reagent caused by the higher mercaptan contents of many West Texas gasolines. Water is formed as a byproduct in the sweetening reaction and that portion which is not soluble in the gasoline leaving the treater will accumulate in the sweetening reagent. The water tolerance limits of the reagent are approximately 9-28 weight percent. When the water content exceeds the upper limit due to accumulation from the sweetening reaction, the gasoline will gradually become doctor sour. At this point, it is necessary to switch to the standby tower, remove the reagent and dry it in some manner. Since the solubility of water in gasoline increases with temperature, this accumulation can be slowed down or in many cases completely prevented by operating at a higher temperature. This can be accomplished either by by-passing a portion of the cooling equipment or installing heating means such as a steam exchange on the treater feed. Some trial and error operation will be required to determine the optimum operating temperature, but it is recommended that the treating temperature never exceed 125° F.

Another problem attendant with the increase in moisture content of the reagent is corrosion of the treating vessel itself. The various lacquers and paints which have been suggested for painting these vessels are the best that have been found but are not completely satisfactory and give only temporary protection. Where corrosion is a really critical item in the operation of these units, we have found that lining the vessel with Saran gives perfect protection. Saran is a synthetic resin and is applied to the interior of the vessel in sheets approximately ¼ inch thick. It is completely resistant to the corrosive action of copper and only one instance has been reported of even minor difficulty with linings of this material. The only disadvantage in its use is the cost which is presently in the neighborhood of $1100 per vessel. It is not recommended therefore for new installations but only in those cases where operating experience has shown corrosion to be a critical item.

In summary, the basic requirements for an adequate natural gasoline plant treating system include: 1) elimination of hydrogen sulfide as early as possible to prevent equipment corrosion; 2) production of specification doctor-sweet and non-corrosive products; 3) operation with a minimum of chemical cost and attention from plant personnel.

To achieve these will naturally require careful consideration for each plant taking into account such factors as products and product specifications, nature and quantity of sulfur compounds present and any special plant or operating conditions which may exist. In general, excluding the exceptional cases, it is our opinion that the most practical and economic treating system for the average gasoline plant will comprise: 1) removal of hydrogen sulfide from the gas prior to absorption; 2) a caustic or amine solution wash on the propane LPG production; 3) copper sweetening of the debutanizer feed or, if the mercaptan content is exceptionally high, a combination of regenerative caustic wash and copper treating. With such facilities adequately designed and properly operated, the operator might reasonably expect a happy life relatively free from treating problems and customer complaints. The latter, however, can never be completely eliminated by any combination of processes known today.

ACKNOWLEDGMENT

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Japanese Industry Takes Another Step Toward Self Support

Rising from World War II ruins are the fractionating, light-ends recovery and stabilization towers of the new thermal cat cracker, Wakayama, Japan.

STANDARD-Vacuum Oil Company has placed its new 3500-barrel-a-day thermal cracking unit on stream at Wakayama, Japan, marking a further step toward placing the Japanese petroleum industry on a self-supporting basis. Built largely out of prewar equipment assembled at the bomb-damaged refinery near Osaka, the addition of the new cracking plant is part of a long-range reconstruction program of Stanvac's subsidiary, Toa Nenryo Kogyo, at its Wakayama and Shimizu refineries.

Prior to World War II, Stanvac had been a petroleum marketer in Japan for more than a half century, but the company first entered the Japanese refinery picture in 1949 with the acquisition of a majority interest in Toa Nenryo. Postwar operations began at Wakayama in April, 1950. Since then, utilizing war-damaged towers, heat exchangers, pumps and oil lines, the plant has been given a two-stage atmospheric pipe still and wax-pressing facilities for the production of lubricants. The present crude charging rate of 5500 barrels a day is based upon current crude oil allocations, although the refinery has a charging capacity of 10,000 barrels daily.

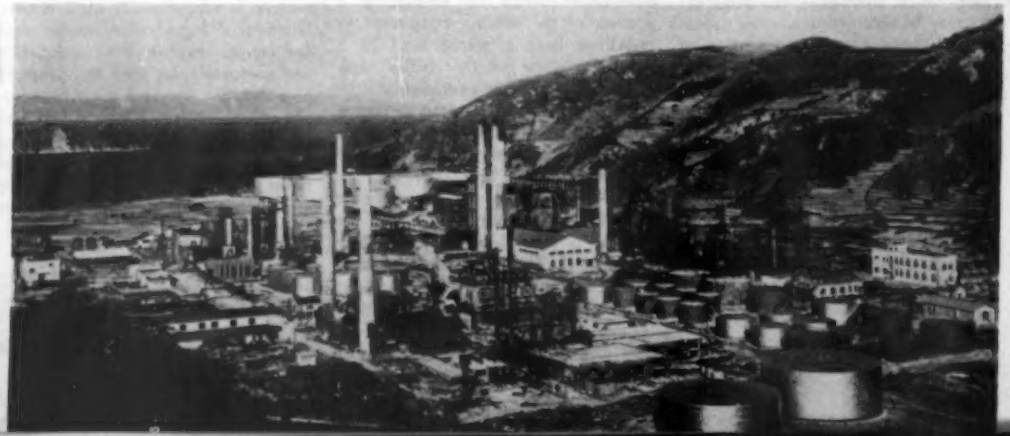
In addition to the new thermal cracking unit now on stream, de-asphalting and phenol extraction facilities are planned for completion later this year to upgrade lubricant quality other facilities to increase lubricant production eventually to around 900 barrels daily are in the planning stage, according to Stanvac.

Shimizu, originally a lubricating oil refinery, also has been revamped to increase its charging rate and to diversify its product range. Operations began in February, 1950, and the Shimizu plant jumped quickly from 1200 to 4000 barrels daily and currently is charging 5000 barrels a day on allocation. New equipment in use includes a 350-barrel-a-day solvent de-waxing unit.

About 90 percent of Japan's oil has to be imported either as crude oil or finished products. Beginning last October the importation of crude oil was authorized by occupation authorities on a commercial basis. Previously only refined products were allowed to be imported by occupation authorities with funds appropriated by the U. S. government.

Japanese consumption of petroleum, still rationed, has increased from about 30,000 barrels daily to 40,000 barrels a day since the oil companies were permitted to resume competitive marketing operations in April, 1949. The two Stanvac plants now supply approximately one-fourth of all the petroleum products consumed by the Japanese people.

Recent photo of Wakayama refinery near Osaka. Deepsea tanker facilities are behind hill at right.



Spent Acid Recovery Offers Solution for Tight Sulfur Supply

F. J. BARTHOLOMEW
New York

RECENT market developments indicate that sulfur prices are on the upgrade with every sign pointing to a trend which has little chance of being reversed. Basic reason for this situation is the fact that the end is in sight for the best sulfur deposits now known to exist in the United States. Although there are other sources of sulfur, as, for example, pyrites deposits, the cost of producing acid from such raw materials is higher. Thus, no matter how one views the future, sulfur is bound to remain in short supply and is going to cost more as time goes on. And this means a higher price tag on sulfuric acid for the petroleum industry.

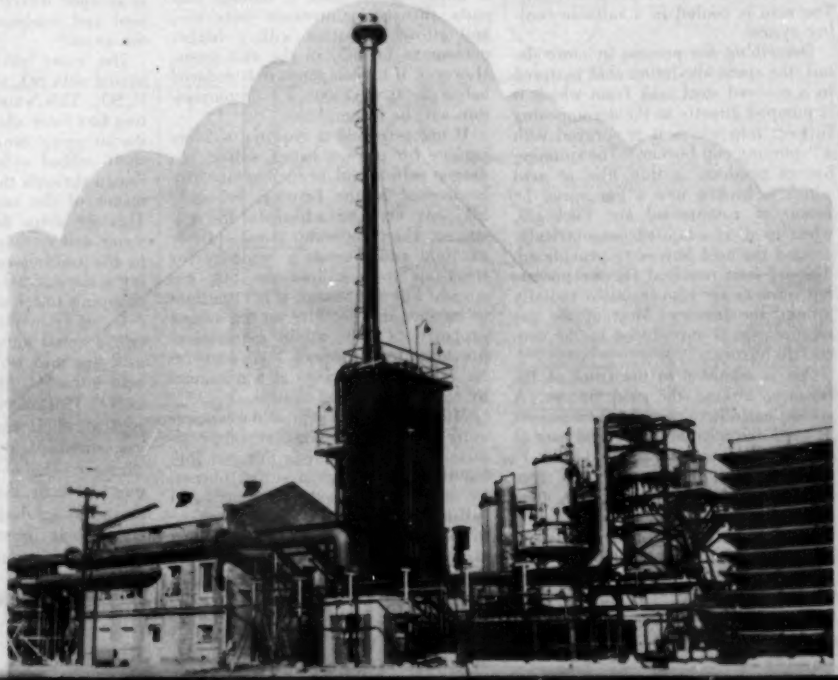
As a result of this change in the economic picture relating to a commodity used in great quantities for oil refining, it may be necessary for the industry to widen the practice of recovering acid from waste products by processes which have been in limited use for a number of years.

SINCE 1939, the petroleum industry has employed a process involving the synthesis of an iso-paraffin hydrocarbon with an olefin, in the presence of a catalyst, to form alkylates which are added to high grade fuels to produce 100-octane aviation gasoline. The process is known as the alkylation process and the most widely used catalyst is sulfuric acid.

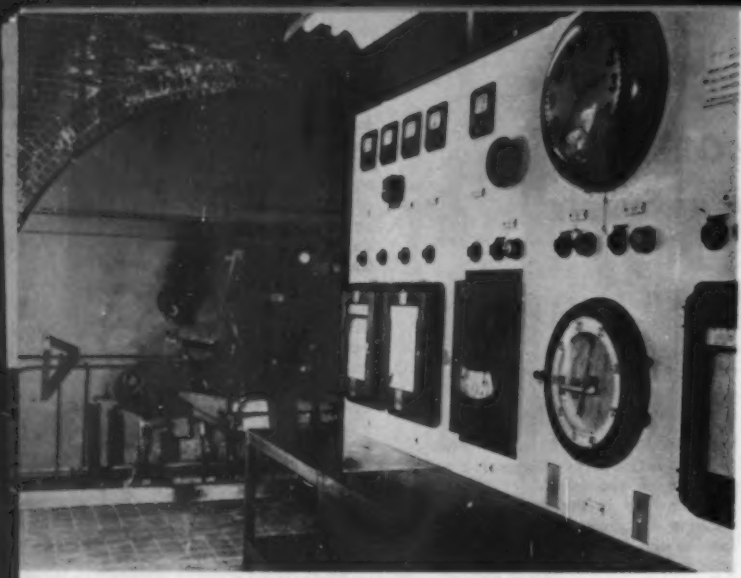
Generally, fresh 98 percent acid is added continuously and spent acid containing 88-92 percent H_2SO_4, 6-10 percent hydrocarbon and the balance water, is drawn off. The spent acid is black in color and fluid at atmospheric temperatures. Several installations for reclaiming 98 percent strength sulfuric acid from this alkylation spent acid have been in successful operation since World War II.

Briefly, the process consists of spraying the spent acid into a fire-brick lined furnace where it is decomposed to form sulfur dioxide at a temperature of approximately 2200° F. Hydrocarbons in the sludge, with the addition of gaseous fuel (if needed), furnish the heat required to decompose the acid. Sulfur or hydrogen sulfide may be substituted for carbonaceous fuel. This provides heat for decomposition and at the same time adds to the acid production to cover process losses. Gases leaving the decomposing furnace pass through a recuperator where heat is recovered by preheating the air entering the furnace. The hot gases are then scrubbed with acid and cooled by direct contact with water.

Sulfur dioxide dissolved in the water leaving the wash tower is recovered by stripping with air and any sulfuric acid mist escaping the furnace is removed in an electric mist precipitator operating at high voltage. Water vapor is removed from the gas stream by scrubbing with sulfuric acid in a



One Hundred-Ton Alkylation Spent Acid Recovery Plant. (Photo courtesy Chemical Construction Corporation.)



Decomposition Furnace and Control Panel. (Photo courtesy Chemical Construction Corporation.)

drying tower and the heat of absorption is removed from the circulating acid in a suitable cooling system. A centrifugal blower is located after the drying tower to propel the gases through the system.

The SO_2 gases are then preheated and converted to SO_3 by passing through layers of vanadium catalyst in standard converters. The hot gases leaving the catalyst layers are used to preheat the incoming SO_2. The SO_3 leaving the converters is partially cooled and then absorbed in strong sulfuric acid where it combines with water to form 98 to 99 percent H_2SO_4. The acid is cooled in a suitable cooling system.

Describing the process in more detail, the spent alkylation acid is stored in a covered steel tank from which it is pumped directly to the decomposing furnace into which it is sprayed with a "spinning cup burner." The spinning burner produces a thin film of acid which is broken into a fine spray by means of compressed air. Fuel gas, when used, is admitted concentrically around the acid burner to provide additional heat required for the process but burners are also installed radially around the furnace. Most of the gas requirement is introduced in the concentric burner.

Air is admitted at the front of the furnace, around the acid burner. A silicon carbide tubular heat exchanger of the Fitch recuperator type is used to preheat this air to about 1700° F. using the heat in the exit gases from decomposer furnace previously mentioned.

An air fan is provided for use in starting up the furnace, at which time the furnace is under a slight pressure with discharge gases going to the atmosphere through the scrubber tower. During normal operation the furnace is under a slight vacuum and the fan is used to overcome some of the pressure loss in the recuperator.

The furnace is designed to operate at a temperature of 1900 to 2300° F. with preheated air of 1600 to 1700° F. The oxygen content of the gas leaving the furnace should be so regulated that all of the H_2SO_4 is reduced to SO_2 with a negligible amount of SO_3. Operation in the lower temperature range is advantageous since it reduces fuel costs, furnace maintenance costs, etc., and allows operation with a higher percentage of SO_2 in the exit gases. However, if the temperature is reduced below 1900 to 2000° F., decomposition will be incomplete.

If make-up acid is required to compensate for process losses, sulfur, hydrogen sulfide and/or mercaptans, can be burned in the furnace, or waste SO_2 gas may be added to the gas stream. The recuperator is not entirely gas-tight and there is a tendency for some air to leak into the SO_2 gas stream. For this reason it is important to balance the pressure on the system properly so as to attain a minimum pressure drop through the recuperator. This is easily kept at a minimum by careful operating control.

Molten sulfur is kept at the temperature for best atomization (approximately 275° F.) and is pumped into the furnace through a sulfur burner, by means of steam-driven centrifugal sulfur pumps. Reasonable care is taken to see that there is always sufficient air for the sulfur and fuel being burned, as lack of sufficient air might cause sublimation of the sulfur.

Gases leaving the recuperator at about 1120° F. enter a steel shell scrubbing tower, lined with sheet lead and acid proof masonry and packed with spiral rings. The gases are cooled by direct contact with recirculated liquor to approximately 200 to 250° F. Sulfuric acid of 46 to 60° Be. is used as the recirculating liquor. This liquor is cooled by means of cooling water flowing through lead coils immersed in lead cooling tanks.

Sulfuric acid mist which might be formed in the process is partially removed in the scrubbing tower. Mist recovered by the mist precipitator is also returned to the weak acid cooling tanks for recirculation. The concentration of the acid on the scrubber towers can be controlled by applying more or less cooling in the ciculating system. The higher the temperature the higher the concentration of the circulating acid.

As the quantity of acid in the circulating system increases, part is removed from time to time and added to the 93 percent acid circulating through the drying tower. The function of the cooling tower is to cool the gases and simultaneously to clean it of any dust or other foreign matter which might be carried over from the furnace or recuperator.

Gases are further cooled to 100° F. in a cooling tower, similar in construction to the scrubbing tower except that this tower contains no packing. For this purpose fresh clean water reasonably free from chlorine, H_2S and salts is sprayed directly into this tower to cool and condense water vapor from the gases.

Hot water leaving the tower is saturated with SO_2 and contains traces of H_2SO_4. This water goes to a distributing box from which it is pumped over the stripping tower, a lead-lined steel shell packed with spiral rings. Air is drawn through the stripping tower by means of the suction on the system. This air strips the SO_2 from the hot water and returns the SO_2 air-mixture to the cooling tower. Water containing a trace of SO_2 discharges from the stripping tower directly to the sewer.

Gases from the cooling tower contain a small amount of sulfuric acid as a fine mist which must be removed before the SO_2 gases can be converted to SO_3. This mist results from the presence of small amounts of SO_3 in the gas stream leaving the combustion chamber. The physical nature of this mist is such that it cannot be removed by scrubbing, so a Cottrell precipitator is provided to remove this mist before it enters the drying tower.

The electrostatic charge on the mist particles causes them to travel toward the positive electrode and collect on the side walls of the tubes. The resulting weak acid solution runs down the tube walls and out of the precipitator through a sealed boot from which it flows by gravity into the scrubbing tower cooler tanks.

Removal of Moisture

Clean gases leaving the precipitator are saturated with water vapor and next pass into a drying tower, a steel shell lined with acidproof masonry and packed with spiral rings. Here the moisture is removed from the gases by absorption in 93 percent sulfuric acid which is circulated over the tower from the pump tank consisting of an acidproof masonry lined steel shell. The acid discharges by gravity from the drying tower and passes through cast iron cooling coils connected by cast iron lines to the pump tanks. Water sprayed over the surface of these coolers removes the heat generated by the absorption of the water vapor in the strong acid. Part of the acid circulated over the drying tower is withdrawn continuously and is replaced by stronger 98 percent acid in quantity sufficient to maintain the strength of the circulating acid constant at about 93 percent.

Air sufficient to dilute the SO_2 content of the gases to about 8 percent is also admitted at the drying tower and the entire volume of gas passes through a centrifugal blower-exhauster located in the system after the drying tower. This blower maintains the entire purification system previously described under a slight vacuum and delivers the gases under pressure to the primary and secondary heat exchangers.

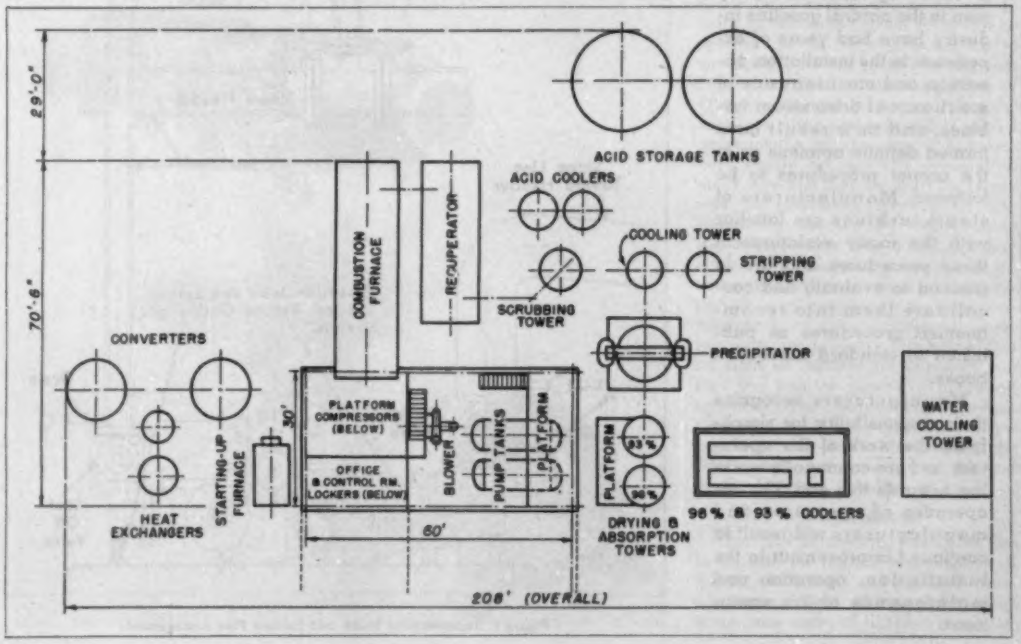
In order to obtain a gas of the highest possible dryness, certain conditions of temperature, acid strength and circulation volume must be maintained. Naturally, proper acid distribution over the tower is of utmost importance.

In the heat exchangers the gases are heated to approximately 800° F. before entering the primary converter. The highest conversion efficiency is obtained only by careful control of temperatures in the catalyst beds. Two tray converters are arranged in series with a heat exchanger in between for control of temperature. In the primary converter SO_2 oxidizes to SO_3 producing heat which raises the temperature of the gas mixture rapidly to about 1100° F. After leaving the first converter, the gases are again cooled to 800° F. by passing through the hot side of the secondary heat exchanger where heat is given up to the SO_2 air mixture before it enters the primary converter. This cooling is of importance in order to finish the reaction and obtain the highest possible yield.

The gases then enter the secondary converter where any residual unoxidized SO_2 is converted to SO_3. This secondary conversion produces additional heat, raising the gas mixture to approximately 860° F. The gases are then passed through the hot side of the primary heat exchanger where heat is transferred to the incoming cold SO_2 air mixture, and are thereby cooled to approximately 475° F. before entering the absorption tower.

The absorption tower consists of a steel-shell lined with acidproof masonry and packed with spiral rings. The SO_3 in the gas stream is completely absorbed in 98 percent sulfuric acid which is circulated over the tower. Part of the 98 percent acid produced in the absorption tower is delivered continuously to the drying tower to maintain the strength of drying acid at 93 percent, and the 93 percent acid withdrawn from the drying tower is mixed with the absorbing acid which provides part of the water required for the formation of H_2SO_4 from SO_3. The remainder of this required water is introduced directly into the absorbing acid. Clean water-white product acid is continuously bled off the circulating stream and stored in steel tanks for future use.

Layout Showing 100-Ton Alkylation Spent-Acid Recovery Plant. (Drawing courtesy Chemical Construction Corporation.)



MAINTENANCE And OPERATION
How To Do It-

Installation, Operation, Maintenance of Mechanical Drive Steam Turbines

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Elliott Company, Jeannette, Pa.

IT IS recognized that many men in the natural gasoline industry have had years of experience in the installation, operation and maintenance of mechanical drive steam turbines, and as a result have formed definite opinions as to the proper procedures to be followed. Manufacturers of steam turbines are familiar with the many variations in these procedures and are in position to evaluate and consolidate them into recommended procedures as published in standard instruction books.

Manufacturers recognize their responsibility for simplifying the work of the operators, and are continually working towards this end. The cooperation of operators and manufacturers will result in continued improvement in the installation, operation and maintenance of this equipment.

THE installation of steam turbines has a decided influence on their future performance. Steam turbines today are ruggedly designed, precision built, high-speed machines which, if correctly installed, will operate satisfactorily for many years. The men responsible for their installation should have a working knowledge of their basic design and general operating characteristics to intelligently supervise their installation.

To install a steam turbine properly, a substantial, rigid foundation should be prepared. This foundation is normally made of concrete and is isolated from other foundations carrying rotating or reciprocating apparatus. The turbine is secured to the foundation by means of foundation bolts embedded in the concrete with ample allowance for shims between the turbine and the foundation to permit adjustment in alignment of the turbine with the driven apparatus.

The alignment of the turbine with the driven unit is important and little reliance should be placed on the flexible coupling for the correction of misalignment. A steam turbine should be aligned, first, when the turbine and driven machine are cold and then, again, when the turbine and driven machine are at normal operating temperatures. The turbine should then be carefully doweled in place so as to prevent, as far as possible, future movement of the turbine. Modern day designs, with centerline bearing supports, reduce the variation in the alignment between hot and cold but, regardless of this, a careful recheck of the alignment should be made when the equipment is at operating temperatures.

The next item of importance in the installation of the steam turbines is the steam piping to and from the turbine including the protective devices incorporated therein. Figure 1 shows a piping arrangement for a steam turbine.

Note that the high-pressure steam line is taken from the top of the steam header so as to eliminate, as far as possible, entrained water in the steam supplied to the turbine. The steam line is made in the form of a loop which absorbs the stresses set up in the piping due to temperature changes. Next, note that the shutoff valve is located

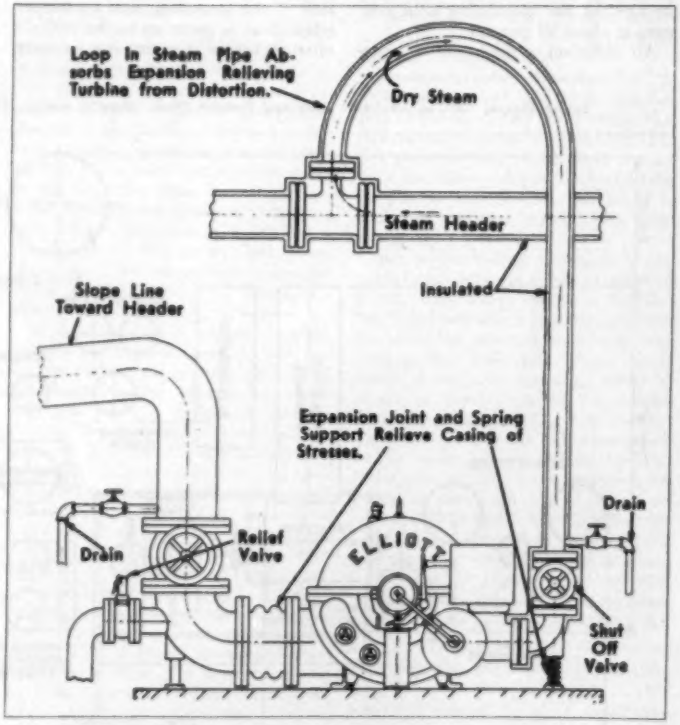


Figure 1. Recommended Steam and Exhaust Pipe Arrangement.

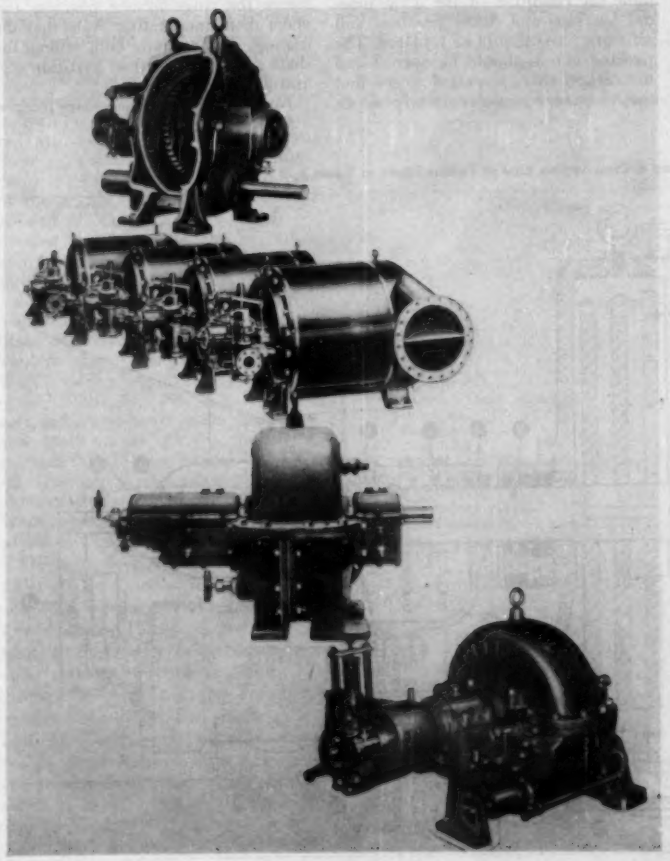
in the steam line just ahead of the turbine so that the operator can be close to the turbine and observe its operation during startup. This shutoff valve is also required so that live steam can be shut off at the turbine inlet flange so that normal maintenance, inspection or replacement of any parts can be made without shutting off the steam in the main header. The drain line immediately ahead of the shutoff valve is required to drain the accumulated condensate in this line before starting. Likewise, the drains from the turbine steam chest and casing should be properly piped up so that they can be opened to remove accumulation of water at these points. It is important that the turbine be properly drained and that the condensate in the line ahead of the turbine be removed so as to eliminate, as far as possible, undue strains caused by slugs of water going through the turbine.

Due to the larger size of the exhaust piping, it is recommended that an expansion joint be placed between the turbine exhaust flange and the exhaust piping to remove piping strains from the turbine casing. The exhaust piping beyond the expansion joint should be supported and anchored as illustrated. Piping strains on the turbine casing may cause misalignment between the turbine and driven machine and, under some conditions, may even cause fracture of parts on the turbine.

Following the expansion joint and ahead of the shutoff valve in the exhaust line is an atmospheric relief valve. This valve should be designed to pass the maximum quantity of steam which the turbine will pass when maximum steam pressure is applied to the turbine inlet and the shutoff valve is closed in the exhaust line. The valve should be designed to be fully open when the maximum allowable pressure on the turbine casing is reached. This pressure is usually considerably in excess of the normal exhaust pressure at which the turbine is operated.

Summarizing this general arrangement, it is noted that we are primarily endeavoring to eliminate strains on the turbine casing, protect the turbine from excessive exhaust pressures and make it possible to work on the turbine without shutting down the entire plant.

Figure 2. Progress in Mechanical-Drive Steam Turbines over Past 50 Years. See text, page 107.



Operation

After the unit has been properly installed, the operation of the steam turbine is a relatively simple and routine matter. Before starting the turbine, the operator should make sure that the steam line and turbine casing are drained of any accumulated condensate, the exhaust line is open to the header, the bearing reservoirs are full and the oil rings are free to rotate properly. The turbine emergency trip valve should be manually tripped to insure proper functioning in case of an emergency during operation.

With the simple and rugged construction of a single-stage turbine equipped with mechanical shaft governor, it is not necessary to warm up the turbine casing or lubricating system and slowly bring the unit up to speed but, instead, it may be put to work as fast as the steam valve can be opened. As the turbine comes up to speed, the operator should be sure that the turbine does not show any signs of vibration or unusual noises. After the unit is running and before it is placed permanently on the line, the governors should be carefully checked to make sure that they are working freely and the emergency overspeed trip should be checked by overspeeding the unit to make sure that this safety device will function properly in an emergency. After the unit is in operation, it is only necessary to make periodic checks to make sure that all working parts are properly lubricated, that no signs of distress are apparent and that the unit is generally operating smoothly. The most obvious indications of trouble are vibration and unusual sounds. Any vibration can be felt or seen most readily at the end of the governor spindle.

Maintenance

The third part of this discussion has to do with the normal maintenance of the steam turbines and although manufacturers would like to have operators take care of it like a mother

takes care of a new-born child, it is realized that the application of the turbine will determine the permissible maintenance. The installations with which plant men are usually involved require continuous operation over long periods of time during which shutdowns are not permitted. With this in mind, there cannot very well be recommended weekly or monthly inspections which would involve tripping the unit out by overspeeding, inspection of the bearings, checking the properties of the lubricating oil, cleaning the governor parts and checking unit alignment. Instead, there is recommended a careful and complete inspection during each shutdown period so that any worn or damaged parts are replaced with a minimum of inconvenience. An ample supply of normal wearing parts should always be on hand for such occasions.

If these shutdown periods are as infrequent as every six months to a year, the entire governing system should be dismantled, cleaned, carefully inspected, and all worn parts replaced.

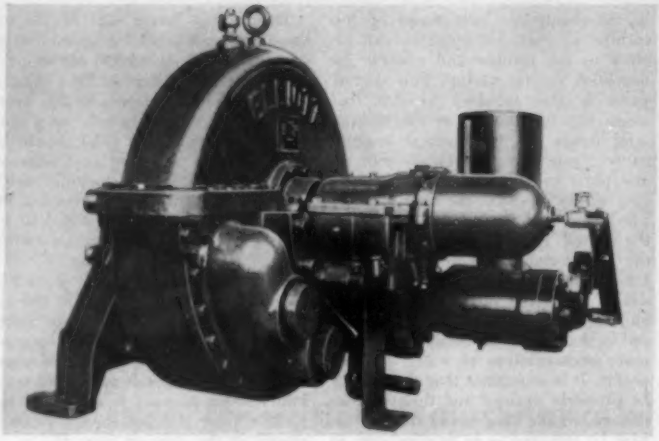
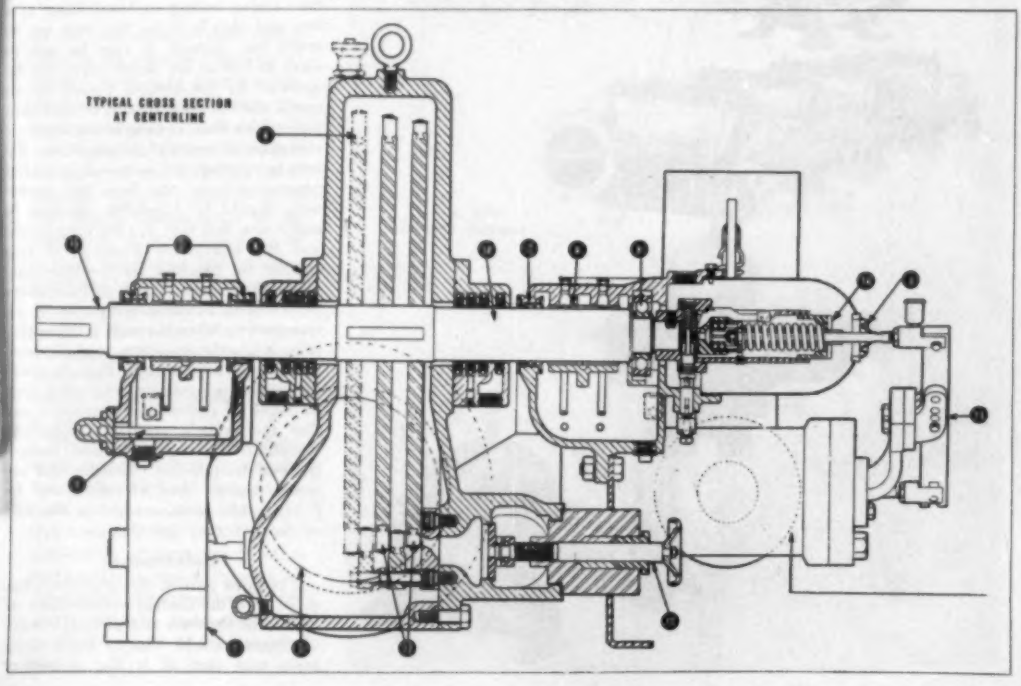


Figure 3. Up-to-Date Version of Steam Turbines.

The clearance of the moving parts should be carefully checked to determine the condition of the main journal bearings and thrust bearings and all worn parts should be replaced. The packing glands should be opened and the carbon rings inspected to see that they are functioning correctly as an accumulation of impurities carried over from the boiler may readily freeze the rings in one position and make them inoperative. Note that the sealing surfaces are both along the shaft and on the vertical partition separating the rings.

Normally, it is not necessary to open

Figure 4. Cross-Section View of Turbine Shown in Figure 3.



up the casing to inspect the rotor nozzle ring, etc., unless the unit is operating on wet steam or if the steam is contaminated. At times when lack of power is noted, it is advisable to inspect these parts to determine whether or not the steam passages are worn or possibly clogged by impurities from the steam.

After this inspection, the turbine should be reassembled and adjusted in accordance with the detailed instructions provided in the manufacturer's instruction book. It is assumed that the men who actually do this work have had access to the manufacturer's instruction book where detailed written instructions supplemented by illustrations are available.

So far, the problem has been discussed from the operator's standpoint. Now the manufacturer's standpoint will be investigated.

Operating conditions for turbines are rapidly changing as a result of increased speeds of driven machines, super-imposed steam generating plants and a general trend toward higher over-all plant efficiency. It is, therefore, an obligation of the manufacturer to modify his turbine to meet these changing conditions and in doing so incorporate in his design any new or desirable features which will assist in turbine installation, operation and maintenance. These modifications, however, must be made with a minimum expense so that the added cost of the original installation is not increased in excess to the resultant reduction in the cost of the operation and maintenance of the modernized turbine.

Figure 2 illustrates the progress made in mechanical-drive steam turbines over the past 50 years. At the top, is shown the original Pelton Wheel design turbine which, obviously, is suitable for only low-pressure, low temperature steam, low-speed and small ratings. This is one of the original single-stage steam turbines manufactured in this country and one of these turbines is now located in the historical museum of the Franklin Institute in Philadelphia.

The next development is a turbine using the now conventional design of nozzles and buckets and consisting of several stages. The stages are made in what is most aptly described as donuts, and are bolted together by through bolts around the periphery of the turbine parallel to the axis. This, obviously, is a relatively crude design, good for only low pressures and temperatures, low speeds, but is aimed at obtaining relatively high over-all efficiency.

The next picture shows a turbine manufactured in the early 1920's which is the first attempt at mass production of single-stage mechanical drive turbines. This design drastically reduced the initial cost as compared with previous turbines but it, likewise, was designed for low pressures, temperatures and speeds. As a result of progress made in associate equipments, this turbine soon became obsolete and was replaced in the 1930's by the next turbine.

This turbine was designed for modern day pressures and for speeds which were considered high at that time but which subsequently proved to be conservative. The design of this turbine stressed the low-cost mass production resulting in interchangeability of replacement parts.

This line of turbines was again replaced following World War II by a modern and up-to-date version, Figure 3. This is an external view showing the rugged construction, centerline supports, enclosed governors and other features. Figure 4 is a cross section view of this same turbine.

On this modern turbine, note the centerline supports which eliminate as far as possible the alteration in the position of the turbine shaft resulting from changes in temperature in the turbine casing. Progressively increasing pressures and temperatures of the steam supplied to these turbines makes this feature a requirement for modern day installation. The increasing tendency to install steam turbines out of doors unprotected from the elements has made it necessary to completely enclose the governors of the turbine and to seal the main journal bearings. Note that the main bearings are sealed by carefully engineered labyrinth glands which do not require rubbing contacts with the shaft. In arriving at this design, rain, sand and sleet storms were simulated and various designs tested under actual operating conditions before arriving at a final design.

Attention is also called to the separate packing cases which are bolted onto the casing and facilitate inspection and replacement of carbon packing rings. Other refinements, such as

Figure 5. Typical Form Made up by Manufacturers for Identifying Normal Wearing Parts of Turbine.

Purchaser's Order No. 13681

Item No. 48-T

NORMAL MAINTENANCE PARTS LIST

Type 2B YR ____ Standard Turbine

Serial No. 13399

Instruction Book No. 100

	Item	Part Number	Catalog Number	No. required per Turbine
1	Bearing Liner (Upper Half)	523	(1) 645743-1	2
	Bearing Liner (Lower Half)	523	(1) 645743-2	2
2	Oil Ring	624	(1) 480497-1	1
3	Bearing (Thrust)	623	(1) 647644-1	1
4	Snap Ring,	622	(1) P47G4E	1
5	Carbon Ring with Spring and Stop	512	(1) 639169-6	6
6	Valve and Stem Assembly	651-2-3	(2) 633848-11	1
7	Valve Seat	567	(2) 633836-8	1
8	Valve Stem Packing	573	(3) 645410-8B	1
9	Weight Assembly (1 set of 3 weights)	665	(4) 633843-4	1
10	Spring (Governor)	667	(5) 650379-1	1
11	Spindle Bearing (Main)	659	646646-1	1
12	Ball Bearing	662	(5) SAE-6208	1
13	Bearing Case	663	(5) 645648-1	1
14	Spindle	657	(5) 634496-2	1
15	Seal	661	646704-1	1
16	Pin	672	646643-1	1
17	Pin	677	646771-1	1
18	Pin	675	646643-2	1
19	Retaining Ring	673	P27E16	4
20	Valve and Stem Assembly	916-7-8	(6) 638794-7	1
21	Knife Edge	933	650301-1	1
22	Knife Edge	934	650293-1	1
23	Spring	922	645953-1	1
24	Spring (Resetting)	926	647629-1	1
25	Plunger	936	647517-4	1
26	Trip Pin	938	(7) 650329-1	1
27	Trip Spring	940	641587-1	1
28	"U" Lock Staple	942	650093-1	2

stainless steel valves and buckets assure lasting performance from the modern units.

To incorporate these features in the modern turbine without increasing the cost to the purchaser, it is necessary for the manufacturers to spend hundreds of thousands of dollars in engineering studies, patterns, tools, jigs and fixtures. The designer must be familiar with the installation, operation and maintenance of these turbines so that he can appreciate the value of new developments such as the liner type bearings. The application of this type of bearing reduces the cost of replacements to a small fraction of the previous costs and at the same time simplifies installation by eliminating time consuming scraping and fitting.

Although the present-day mechanical drive turbine is built in many sizes, the manufacturers endeavor to obtain interchangeability of parts throughout the line so as to eliminate the need for carrying large stocks of replacement parts. In the past, large users of turbines have been forced to fill their storehouses with rows of bins filled with spare parts identified for each individual turbine with the result that the cost of this investment was excessive. In the modern line of mechanical drive turbines, normal wearing parts such as bearings, carbon rings, governor parts, etc., can be reduced to a minimum by following recommendations of the manufacturers.

Figure 5 illustrates one of the typical forms made up by manufacturers for this purpose. This form identifies the normal wearing parts of the turbines by name and part number corresponding to names and parts numbers in the instruction book provided. The manufacturer's catalog number for each item is, likewise, tabulated and it should be noted that all parts carrying the same catalog number are interchangeable. This form also shows the number of each part required per turbine.

This form is available for every standard single-stage turbine manufactured and should be placed in the hands of the men responsible for ordering and stocking of replacement parts. Obviously, it does no good in the files of the purchasing departments or the general contractors.

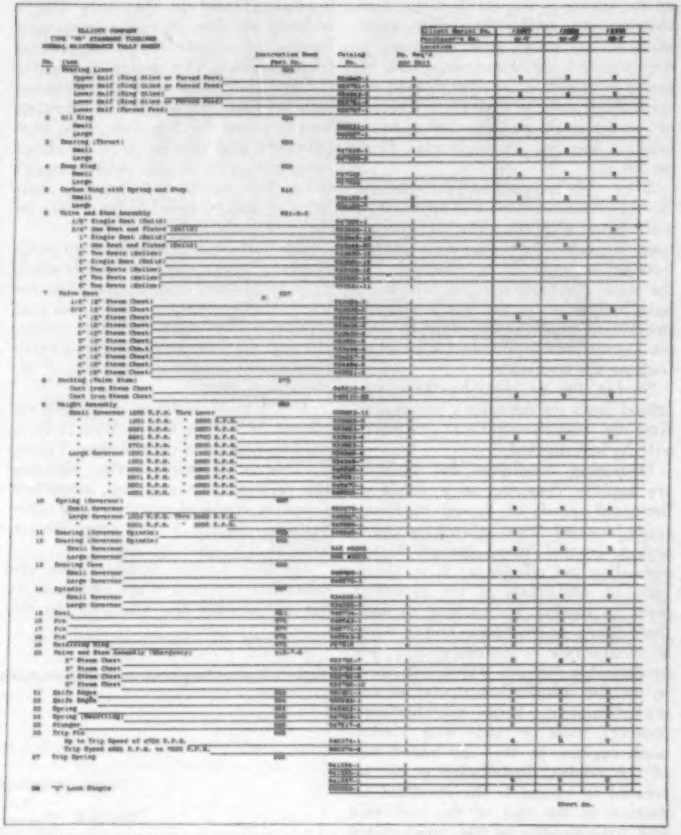


Figure 6. Tally Sheet, Available from Manufacturers, and Kept by Storekeeper.

For an installation involving several turbines, the storekeeper should make up a tally sheet which is made available by the manufacturer (Figure 6). By transferring the data for each turbine onto this tally sheet, the storekeeper can readily determine which parts are common to which turbines and how many turbines use the same parts. From this information, he is then in a position to determine how many of each part he desires to carry in his storeroom.

Since it is impossible to forsee all possible emergencies, there will be times when parts other than those listed are actually required. In these cases, the requirements can be handled on an emergency basis with the manufacturer and by means of special handling, air express transportation, etc., the required parts can be obtained rapidly. As a result, it is usually uneconomical to guard against these emergencies by the stocking of these special parts.

ACKNOWLEDGMENT

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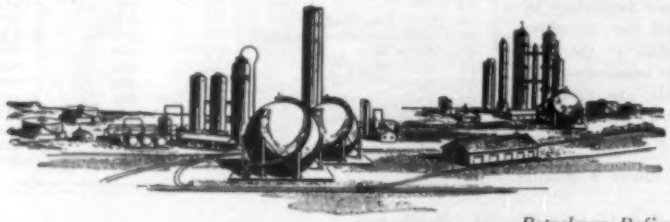


MAINTENANCE And OPERATION How To Do It—

HOW—

Waste Heat Boiler Improves Refinery's Operation and Maintenance of Steam Plant

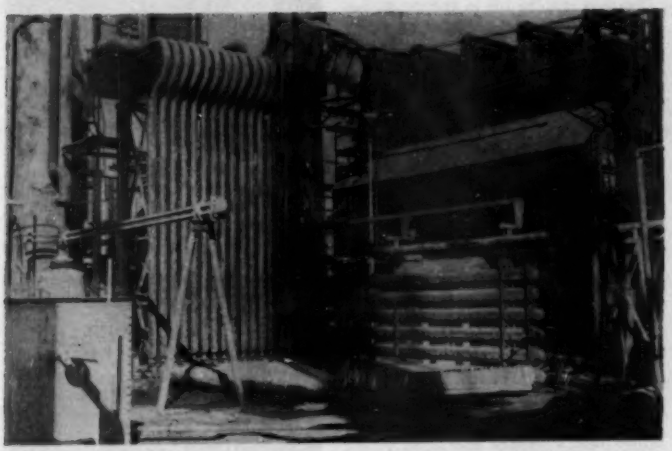
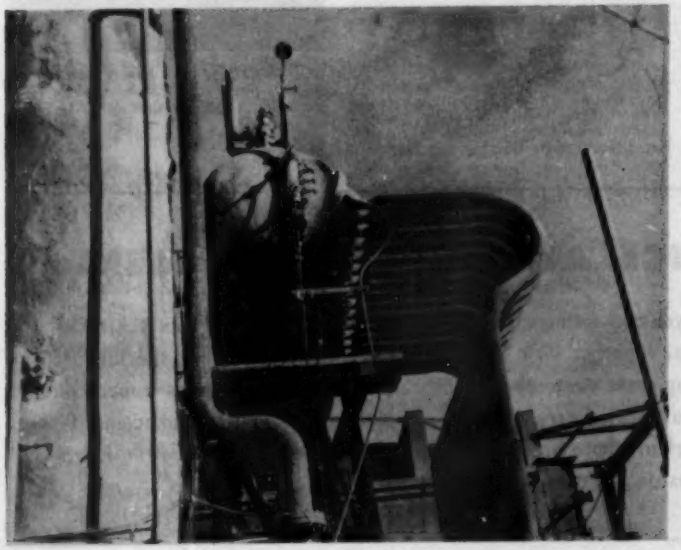


Photo above shows waste heat boiler in California refinery. Note heavy oil heater in background. Photo below shows steam disengaging drum with safety valves, steam risers and gauge glass fittings.



INCREASING the throughput capacity of Rothschild Oil Company's Dubbs cracking plant at Santa Fe Springs, California, required that the residuum coils and the water cooling box capacity be increased. Residuum at 820°F released from the secondary flash column made it imperative that additional cooling be added. To increase the coils and cooling box in size and capacity, the outlay for material and labor would have been considerable. In turn this capacity would call for a greater amount of cooling water and added circulating pump capacity.

George Hartsfield, Manager of Refining Operations, and H. A. Wylie, his assistant decided against increasing the size of the water cooling box and residuum coils, for a method of temperature reduction, calculated to produce 10,000 pounds of steam per hour. By this method, there would be no direct cost for fuel, and the reduction in plant fuel consumption would be considerable making the installation profitable. The water cooling box and residuum coils were to be operated as an after cooler to bring the temperature of the material to that necessary for bulk storage.

The projected waste heat boiler was built and erected by plant employes. The unit was located as near to the cracking plant flash chamber as possible to conserve piping and reduce heat loss. As the battery of refinery boilers had been erected nearby, consisting of ten units, the footage of additional feedwater lines and steam headers was a small matter.

The waste heat boiler consists of 16 fin type tubes, having an outside tube diameter of 3 inches, and an internal tube diameter of 1½ inches, 20 feet long. They are installed in a horizontal position on concrete piers near the ground where they can be serviced and maintained with the least amount of preparation. The unit contains its individual feed water preheater, consisting of six fin type tubes similar to the boiler units, stacked at one side of the waste heat boiler.

Water for this boiler is treated with compound for scale, foaming and corrosion control. The original boiler battery feed pumps are employed for the new unit, thereby eliminating the necessity of any additional pump capacity. The waste heat unit contains a steam disengaging drum in an elevated position, directly over one end of the steaming tubes. This drum is 20 inches in diameter and 12 feet, 6 inches long, equipped with flanged nozzle for 16 steam risers a conventional 3-cock gauge glass fitting and an automatic boiler feed level control. The mud drum is the same size as that of the steam disengaging drum, and is at ground level.

The source of heat for this boiler is

the residuum released from the secondary flash chamber, which travels in parallel through the 16 tubes to a manifold. Part of the material can be diverted through the original submerged residuum cooling coils to obtain required temperature in storage. The manifold is piped so the entire stream of hot residuum can be by-passed from the waste heat boiler, or regulated so as to pass any predetermined quantity through it or the submerged coils.

Water from the feed pumps enters the feed water preheater against oil at an average of 450°F. to produce a feed at a temperature of 210°F. The feed water preheater discharges water to maintain a level 6 inches below the outlet of the steam tubes where they flange onto the steam disengaging drum. The drop in temperature on the hot residuum from the secondary flash to the outlet of the boiler feed water preheater is from 820°F. inlet, to 350°F. outlet. Since the unit is classified as an unfired pressure unit, no special license is required for operation, or the operators, and is actually a residuum precooler between the flash chamber and the coils in the cooling box doing useful work in the meantime.

This unit has delivered 10,000 pounds of steam consistently since it was put into operation, running on an average of 3,000 barrels per day of cracking plant residuum. The most noticeable effect after it was placed on the line was in the performance of the original battery of boilers. Prior to this time, heavy firing was necessary to supply an adequate volume of steam for pumps and processes. Immediately after steam began flowing from the new unit, it was necessary to trim the fires in the boilers to prevent an over abundance of steam.

Maintenance crews may now shut down one or more of the boilers for a thorough cleaning and reconditioning without being rushed for time. If the waste heat boiler requires a shutdown for cleaning, the original units can carry the load because they are maintained in better condition. The tubular sections in the waste heat boiler are attached with individual demountable fittings so that any section can be opened for inspection and cleaning, or one may be removed entirely if necessary.

HOW TO APPLY—

Effective Outdoor Tank Insulation

THE application of insulation and weatherproof finish on an outdoor storage tank in the Midwest illustrates the four steps in an effective technique for insulating large, cylindrical vessels. In the photo, the tank, which will operate at 270° F., is being insulated with 1½-inch-thick mineral wool blankets, in 24 x 48-inch sections, covered with expanded metal lath on one side and wire netting on the other.

From bottom to top in the photo, the four steps are:

1) Mineral wool blankets, metal lath covering on the outside, are tightly butted together and secured to the tank by 1-inch galvanized iron bands encircling the tank on 9-inch centers.
2) A single ¾-inch layer of insulating cement is trowelled into the metal lath covering.
3) One-inch mesh wire netting is stretched over the dry cement.
4) A coat of asphalt mastic, ⅛-inch thick when dry, is trowelled into the wire netting and smoothly surfaced to finish the tank insulation.

The insulating materials and steps illustrated are designed to maintain the temperature of the tank contents under all wheather conditions with minimum maintenance and repair.

HOW—

Special Stand Is Used To Rotate Drums

EMPTYING the contents of filled drums into a supply line is simplified by the special rack shown in the picture. Drums of special chemicals can be hoisted on the rack in a horizontal position to place the side bung uppermost. Fittings, attached to the dispensing line with a lip union, can be inserted into the bung hole. Then, by rotating the drum with the aid of the rollers inserted in the saddles, the fittings can be lowered in position for connection. After the drum has been placed on the rack, or stand, no lifting is necessary, since the rollers permit the filled drum to be rotated easily to any desired position.

Drum stand holds two barrels side by side. Supports fitted with rollers allow drum to be rotated.

MAINTENANCE AND OPERATION MEN!

Have you noticed that you are rating a special section each month in The REFINER? Articles slanted your way together with "How To Do It" items carry your special tag. (Incidentally, you can pick up some spare change by sending in hints such as appear on these pages. It need not be a finished article—your complete notes will be sufficient. Be sure to send either a good clear photo or sketch picturing your idea. Address Editor, Petroleum Refiner, Box 2608, Houston 1, Texas.)

Sweetening and Desulfurization Of Light Petroleum Products

Part VI. Alkaline Reagents

V. A. KALICHEVSKY

Consulting Chemical Engineer

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DESULFURIZING action of alkaline reagents depends on their ability to extract from petroleum sulfur compounds of acidic nature such as hydrogen sulfide and mercaptans. However, under certain conditions other reactions may become of at least equal importance to the refiner. For instance, in the presence of oxidizing substances mercaptans may be transformed into disulfides while sodium sulfide obtained by the inter-reaction of sodium hydroxide and hydrogen sulfide may free the oil from elemental sulfur. A careful study of treating variables is, therefore, of considerable importance for insuring maximum utilization of alkalies in commercial practice.

In the usual plant terminology alkaline reagents comprise oxides and hydroxides of alkali and alkali-earth metals and their salts of weak acids, particularly carbonates. In some respects these reagents appear similar but the chemical and physical characteristics of individual substances are sufficiently different to discourage indiscriminate substitutions. Weak alkalies may be satisfactory for neutralizing strong acids but strong alkalies are needed for the removal of weak acidic substances. Compounds of alkali-earth metals may act in some respects like compounds of alkali metals but increase the ash content of the oil because of adverse solubility characteristics. Alkalinity of sodium and potassium hydroxide solutions may be adjusted to the same level but their viscosities would be different.

Besides certain sulfur compounds strong alkalies dissolve organic acids and phenolic substances. This may or may not result in an over-all improvement in oil quality depending on the nature of these oxygenated bodies some of which may be inhibitors while others accelerators for oxidation reactions. The original object of alkali refining was restricted to purposes other than sweetening or reduction of sulfur content of the oil and only relatively recently these latter possibilities were more or less completely utilized. This was also stimulated by the development of catalytic and high temperature thermal cracking and reforming processes yielding products that contain sulfur compounds of simpler structure than those associated with the products from older processes. However, the diversified action of alkalies makes it not always possible to draw a sharp division between the various benefits which might be derived from their use.

Alkalies may be applied to the oil after they are dissolved in water or organic solvents, or in the solid state. Although they are much more efficient than water some desulfurization and improvement in oil properties may be observed occasionally by washing oils with water which is capable of dissolving appreciable quantities of hydrogen sulfide and certain oxygenated and nitrogen bearing compounds. The use of cold water[125] is preferable but hot water[190] and application of pressure[78] may serve the purpose. However, extraction of acidic substances is greatly facilitated by the presence of even small quantities of alkalies.[80] Washing with water is always helpful for removing from the oil the sulfuric acid reaction products[206] by reducing hydrolysis provided equipment capable of withstanding the action of dilute acid is available.

SODIUM HYDROXIDE, potassium hydroxide, ammonia, lime, and alkaline solutions with solubility promoters are extensively used for the treating of refinery products. This article explains the chemistry of these treating reactions, continuing a series on the treatment of light distillates manufactured from sulfur-bearing crude oils. Subsequent articles will discuss vapor phase and miscellaneous other desulfurizing processes.

Sodium Hydroxide

Water solutions of sodium hydroxide are commonly used for neutralizing acid treated oils[6, 38, 76, 118, 171, 220] but aqueous alcoholic solutions[169] and solid alkalies[164, 179, 180, 198] may be employed if emulsification difficulties are encountered. In this application of alkalies no attempt is usually made to utilize them for purposes other than neutralizing the acid remaining in the oil and treating conditions are adjusted with the sole object of avoiding formation of emulsions and facilitate handling of materials.

Washing the oil with sodium hydroxide solutions improves their odor[180] and has a varying effect on color, oxidation stability, sulfur content and other oil properties. The use of hot or cold alkali solutions was suggested for treating materials like crude oil[18, 77, 170] or naphtha[127] and addition of sodium sulfate[149] and similar salts was recommended for accelerating settling rates. If sodium hydroxide is applied before sulfuric acid treat[112, 131, 142, 143] the color of the oil might be improved and acid consumption lowered. Steaming prior to sodium hydroxide treatment[181] may be helpful in reducing the quantity of alkali needed. Washing the distillates with sodium hydroxide solutions soon after they are produced[116] or immediately after condensation[191, 203] might be beneficial for improving color and color stability. This also permits elimination of hydrogen sulfide before it might oxidize to elemental sulfur which is somewhat difficult to separate from the oil. Occasionally, sodium hydroxide may darken the oil color but this can be usually overcome by washing the distillates with sodium hydroxide solutions or water as soon as they are produced.

If the oil contains appreciable quantities of hydrogen sulfide and mercaptans washing with sodium hydroxide solutions may result in a substantial reduction of total sulfur content.[61] The use of strong solutions is preferred[12] but 10-20° Be' (5-15 percent wt.) solutions may offer an advantage.[25] Strong alkali solutions might be applied at temperatures above 350° F. and under pressure.[67] High temperature treatment may be preceded by washing with a weak alkali solution[22, 134] and followed by redistillation.[22]

The efficiency of mercaptan extrac-

tion depends on the method of applying caustic solutions to the oil. By employing progressively stronger solutions[65] or by changing the treating temperature[138] mercaptans of progressively higher molecular weights may be absorbed selectively or separated from other acidic substances. Similarly, thiophenol may be separated from hydrogen sulfide.[211] The oil may also be distilled into fractions which are treated separately under optimum conditions and the spent solutions combined before they are regenerated by air blowing.[96]

For many years the use of fresh and strong sodium hydroxide solutions was believed to be a necessary prerequisite for efficient removal of mercaptans. However, such solutions frequently impaired oxidation stability of gasolines by removing natural inhibitors of the phenolic type. This can be avoided by employing caustic solutions saturated with respect to phenols but free of mercaptans. Commercially this was accomplished by regenerating the solutions without affecting the content of the oxygenated compounds after equilibrium is established. The method also offers economic advantages by reducing the cost of chemicals.

Further investigations showed that the presence of phenols in caustic solutions increased their solvent power towards the mercaptans making the process very efficient. These findings resulted in the appearance of several refining methods as shown by the following examples. The oil may be treated in two stages. In the first stage a small volume of a 10-20° Be′ caustic solution, about one percent on the oil volume, is employed for removing hydrogen sulfide and organic acids. In the second stage about 25 percent of the solution is used for extracting mercaptans. The spent solution from the first stage is discarded while that from the second stage is regenerated with steam and mixed with the quantity of fresh caustic solution equal to that discarded from the first stage. The mixture of the two solutions is then split into two portions. The smaller portion is diverted to the first extraction stage and the larger portion to the second extraction stage.[101] Counter-current treatment followed by regeneration is often resorted to for improving extraction efficiency.[88,177] Intimate mixing of reagent with the oil is desirable for the same reason.[112] The charge stock may be separated into two fractions. The low boiling fraction is extracted with a sodium hydroxide solution which is reused for extracting the high boiling fraction.[98] The caustic solution may be prepared by adding phenols obtained from an outside source. For instance a fresh caustic solution may be employed for extracting an oil rich in phenolic constituents, phenols liberated by acidification and distilled to separate the high volatile substances. The less volatile phenolic fraction is then dissolved in a strong alkaline solution forming an efficient reagent for extraction of mercaptans.[146] Scrubbing oil vapors with caustic solutions while recycling a portion of the purified heavy constituents has been suggested[168] as well as other methods of applying the reagent[78] including extraction of oils containing sulfur dioxide with hot sodium hydroxide solutions in the presence of phenols and naphthenic acids.[195]

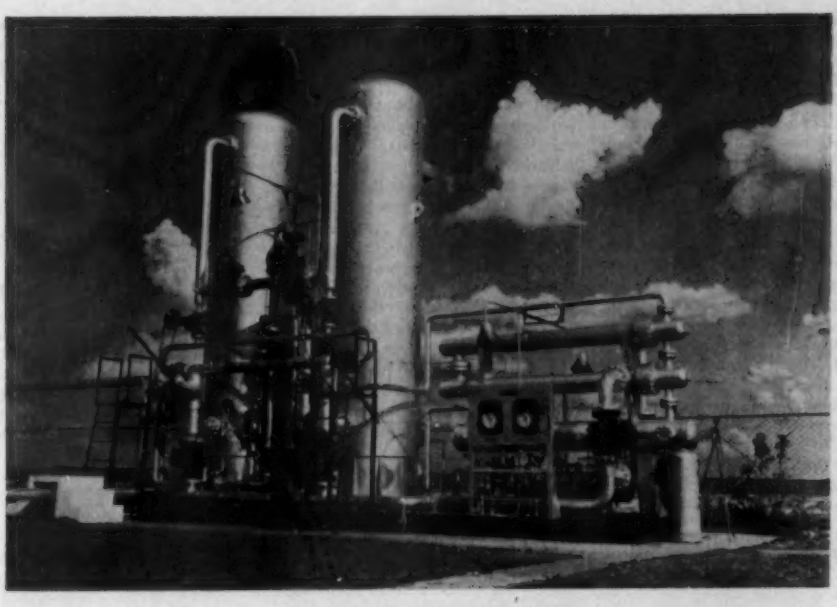
The extraction of mercaptans with sodium hydroxide solutions is seldom if ever sufficiently complete to yield a product passing the doctor test which is capable of detecting the presence of as little as 0.001 percent mercaptans. However, if this is required by specifications a preliminary caustic wash is almost always desirable to reduce consumption of reagents in sodium plumbite,[128,185] lead sulfide[6] and other more expensive treating procedures.[1] For similar reasons application of caustic often precedes refining with a number of other chemicals.[41,132,145,207]

Sweetening with sodium hydroxide solutions may be often accomplished in the presence of simple oxidizing agents which show an improved efficiency in converting mercaptans to disulfides in an alkaline medium. This reaction takes place whenever air or oxygen are introduced and their complete elimination is seldom feasible in commercial practice. For this reason some mercaptans are changed to disulfides which remain in the oil even when complete removal of mercaptans by extraction is attempted. If the volume of air is large the oxidation reaction predominates and little if any mercaptans are removed from the oil in the form of mercaptides. Conversion of mercaptans to disulfides is further accelerated if a small quantity of elemental sulfur is introduced into the oil.

When oil is sweetened with air or oxygen in the presence of alkalies[68] the use of high temperatures, 350° F., or above, speeds up the process.[140] The reaction can be also accelerated by employing catalysts like nitro-, diamino-, nitrodihydroxy-, or nitroamino hydroxybenzenes.[73] However, an indiscriminate use of oxidizing agents must be avoided as they may attack unsaturated hydrocarbons and unstable constituents and thus contribute to high gum content and instability of the product. Instead of oxygen other oxidizing agents may be employed like manganese dioxide,[22] permanganates or bichromates.[45,194] They are claimed to have the advantage of oxidizing phenols and converting them to compounds highly soluble in the caustic solution. However, for the reasons already mentioned the removal of phenols is seldom desirable. Other modifications of this treating method include the use of elementary sulfur,[40] oxygen and active carbon,[174] sulfur, fullers earth and sodium peroxide,[172] or a mixture of sulfides, polysulfides and naphthenates of alkali metals.[106] One of the processes suggests the use of organic peroxides applied to the oil directly and without the use of alkalies[23] but this requires a very close control of the sweetening operation and involves handling of hazardous materials.

The spent alkali solutions are commonly revivified by blowing with steam[12,92,111,163] or air.[96] If steam is used some difficulties might be expected in distilling off the less volatile, high molecular weight mercaptans. In air regeneration only the lighter mercaptans are removed in this manner while the rest is converted to the less volatile disulfides which remain suspended in the caustic solution and are separated by settling. In either case complete regeneration of the spent reagent might not be easy to attain if strong organic acids and thiocresols are present[88] but this is of little importance provided the revivified solution has a high alkali content. In general, regeneration with steam is more desirable than with air when the concentration of mercaptan sulfur is higher than about 0.02 percent[20] assuming no special allowances for variations in the nature of mercaptans. The use of promoters for speeding up the oxidation reactions is a factor in favor of air blowing and is discussed in connection with the solutizer and related processes. Another method of regenerating the spent solutions involves washing them with naphtha containing elemental sulfur[42] to convert mercaptides to disulfides which are removed with naphtha. Oxidation of mercaptides to disulfides can also be effected by electrolysis[214] or by employing oxidizing agents capable of releasing chlorine.[182] Pretreatment with an alkaline hyposulfite solution followed by sodium hydroxide wash containing heavy metals has been suggested.[144]

Recovery of phenolic substances from completely spent alkali solutions is done by employing carbon dioxide or flue gas,[2,111,201] sulfur dioxide,[123] hydrogen sulfide,[128] sulfuric acid[9] and similar reagents capable of displacing



phenols from their solution in caustic. Heating spent solutions to 300-700° F. under pressure results in formation of water and mercaptan phases which can be separated by decanting.[100] Phenols may be extracted from spent solutions with naphtha[165] or hydrocarbon oils having boiling points below that of the most volatile disulfides,[55,102] amyl alcohol,[69] diethylene glycol monomethyl ether[202] and other suitable solvents.[79] Sodium hydroxide may be recovered from completely spent caustic solutions by treating them with lime[95,186] but this is not always economical. One of the proposed methods involves heating the spent solution with the alkali metal plumbite solution to completely decompose the mercaptides.[99]

Phenolic substances found in most gasolines are predominantly m- and p-cresols while those in polymerization gasolines consist mainly of dimethyl- and p-ethyl phenols.[204] Their further purification may involve fractional distillation and various treating operations depending on the desired purity of products. This may include solvent extraction,[202] alternate treatment with reducing and oxidizing agents between the distillation steps[24] and combinations of these procedures.[19]

The reuse of alkali solutions may enhance emulsification difficulties due to the presence of organic acid soaps and some of the inorganic salts. This may be avoided by employing demulsifying agents like alkali metal salts of green acids,[161,189] petroleum carboxylic acids[72] or chromic acid,[187] but care must be exercised to prevent possible contamination of the oil. The oil may also be recovered by heating the emulsion under pressure and settling.[90]

Sodium hydroxide solutions used for extraction of hydrogen sulfide and containing sodium sulfide may be utilized for removing from the oil the strong organic acids.[50] The spent solutions are also capable of removing elemental sulfur[124] by changing sodium sulfide into polysulfide. Sulfur removal improves with increasing temperature, time of contact and ratio of alkaline solution to the distillate.[5] Alkaline-earth sulfides enter into similar reactions.[60] Alcoholic solutions of the sulfides are more efficient desulfurizing agents than the water solutions.[125] If both hydrogen sulfide and elemental sulfur are present they may be removed simultaneously with very small quantities of strong sodium hydroxide solutions.[59] Oil containing mercaptans and elemental sulfur can be sweetened with greater ease if the sodium hydroxide solution contains small quantities of copper hydroxide and lead sulfide.[166] Oils can also be sweetened by contacting with a solution of alkali polysulfides which is revivified with elemental sulfur.[43] A somewhat similar method involves the use of spent sodium hydroxide solutions, elemental sulfur dissolved in naphtha and lead as the catalyst.[44]

Application of anhydrous alkalies to the oil presents certain handling difficulties but the advantage of using them consists in their ability of quantitatively extracting the mercaptans.[200] The reaction is slow because the sodium mercaptides formed on the surface protect the inside of the reagent from direct contact with the oil. The difficulty may be overcome by using alkalies in a finely divided state with particle sizes of colloidal dimensions.[115] The presence of moisture must be avoided because the reaction is sensitive and does not proceed to completion if the oil or alkalies are not moisture free. However, once the mercaptides are formed they can be washed from the oil with water as they hydrolyze slowly. Similar attempts of employing anhydrous alkalies in the past include agitating the oil with sodium hydroxide solution followed by the use of dehydrating agents,[4] digesting the oil under pressure with cotton waste saturated with alkalies[190] or filtering the oil through solid alkalies[137] which may be deposited on an inert material.[82]

Contacting the oil with solid alkali hydroxides in the presence of oxygen and sodium naphthenate[105] results in sweetening of the oil by conversion of mercaptides to disulfides. This is not accompanied by the reduction in the sulfur content of the finished product.

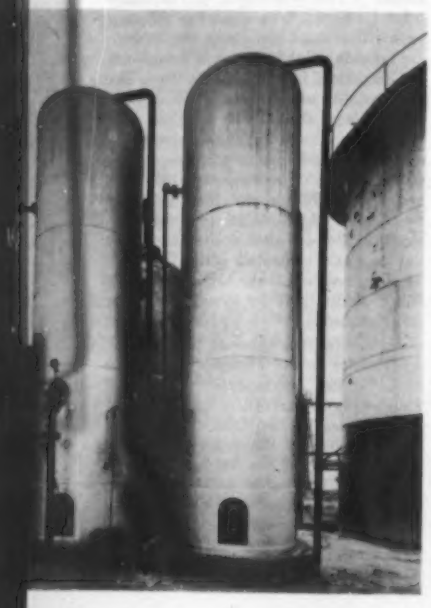
Sodium hydroxide and other alkalies may be applied to the oil in solution of organic solvents. Sweetening may be accomplished in two ways depending on the method of applying the reagent. If water is present the

organic solvent which must be highly soluble in the caustic solution, increases the solubility of mercaptans in this solution thus facilitating their removal.[169] This has been briefly described in connection with the use of caustic solutions containing phenols and will be discussed in more detail in connection with the solutizer and related processes. In the absence of water the organic solvent is dissolved by the oil and sodium hydroxide precipitates out from its solution in a very finely divided state. This precipitate absorbs the mercaptans in the form of mercaptides which can be washed out with water as previously mentioned. The reaction is fast on account of the large surface exposed and the quantity of alkalies used may be held close to the stoichiometric proportions. No moisture should be present as the reaction will not proceed to completion unless the organic solvent and oil are free of water.[39,155,200,21]

Sodium carbonate is used occasionally as a substitute for sodium hydroxide but it seems doubtful whether the difference in price offsets the inconveniences which are caused by employing this reagent at the plant. The removal of weakly acidic constituents from the oil is incomplete while liberation of carbon dioxide may cause foaming and formation of emulsions.

Sodium carbonate may be applied in water solution or as a dry powder. A mixture of dry reagent and diatomaceous earth has been suggested for neutralizing acid treated oils.[81] Sodium carbonate may be employed for removing hydrogen sulfide[178,183] and the spent solution regenerated by blowing with air in the presence of nickel or cobalt sulfide catalysts.[178] Claims were advanced that mercaptans can be removed by hydrolyzing the sodium carbonate solution to form hydroxide and bicarbonate solutions, using the sodium hydroxide solution for extracting mercaptans, mixing the spent solution with the bicarbonate solution to liberate the mercaptans, steaming the water solution to expel the rest of the mercaptans and finally electrolyzing it to generate the hydroxide and the bicarbonate ions.[16] Addition of arsenic trioxide to sodium carbonate solutions improves their desulfurizing efficiency[93] which is also enhanced by the presence of sodium chloride and silver or metals like aluminum.[205] Distillation of petroleum oils in the presence of sodium carbonate has been suggested.[10]

Sodium aluminate is another sodium compound recommended for refining oils[129] but to the writer's knowledge is not in commercial use.



Potassium Hydroxide

For many years the refining properties of potassium hydroxide were believed to be the same as those of sodium hydroxide and no advantage was expected to be gained by the use of the more expensive reagent. However, detailed studies of the physical and chemical properties revealed that in many instances considerable benefits could be realized by employing potassium instead of sodium hydroxide while the expense involved was greatly reduced by the introduction of regenerative processes. As a result a number of plants began to use potassium hydroxide in some of their routine operations.

For the same concentrations of the hydroxyl group sodium and potassium hydroxides appear to be equally effective in extracting mercaptans and weakly acidic substances. However, the highly concentrated sodium hydroxide solutions have very high viscosities and cannot be successfully handled in commercial practice because of emulsification difficulties. This obstacle is not encountered with the potassium hydroxide solutions which have relatively low viscosities. For this reason their effectiveness can be maintained at a higher level than that of sodium hydroxide solutions.

Observations were made that potassium hydroxide might be more efficient in removing elemental sulfur and less efficient in extracting the mercaptans than sodium hydroxide[200] and that the use of the mixture of two chemicals may offer an occasional advantage.[114] However, anhydrous potassium hydroxide by itself[208] or in alcoholic solution[176] is a very effective desulfurizing agent.

The methods of applying potassium hydroxide to the oil and of regenerating spent solutions are the same as those described in connection with sodium hydroxide.

Ammonia

Neutralizing acid treated oils with ammonia obviates the emulsification difficulties that might be encountered by employing other alkaline reagents.[181] Some desulfurization may be effected by extracting oils with liquid ammonia[56,57] by treating oils at elevated temperatures with hot ammonia vapors and steam[58] or by applying anhydrous ammonia to the oil in the presence of a catalyst and an alkali metal compound containing oxygen.[7]

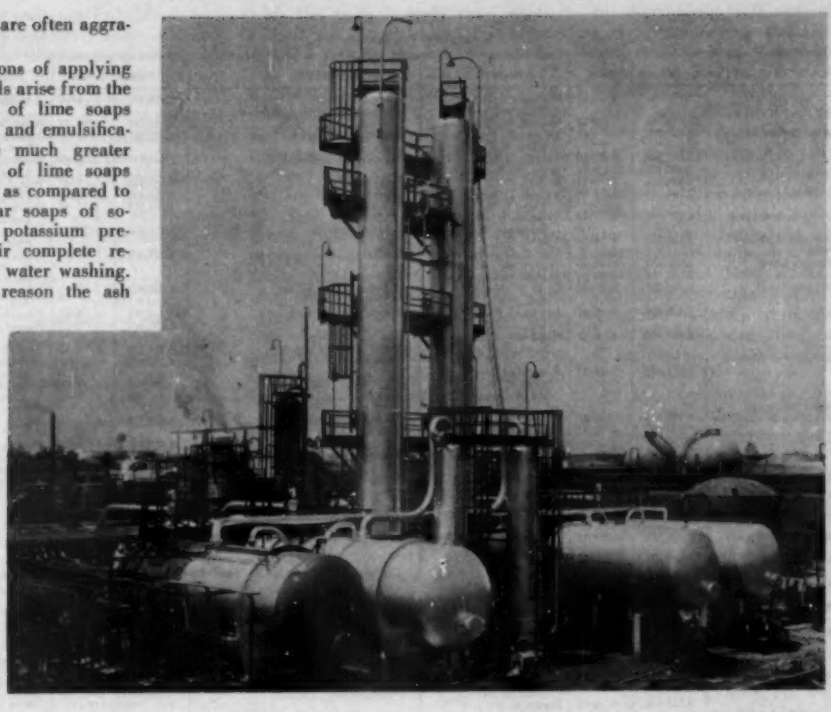
Ammonia is a weaker alkali than sodium or potassium hydroxides but within these limitations it is comparable with them and may be often employed as a substitute. The use of ammonia to prevent corrosion of equipment is quite universal. However, no definite advantage seems to be associated with ammonia as a treating agent while some difficulties may be encountered in handling it without the corresponding economic benefits.

Alkali-Earth Compounds

Lime has been suggested for neutralizing acid treated oils[82,84,197] and as an independent refining agent. The methods of applying it to the oil may vary considerably. The oil may be mixed with anhydrous, unslaked lime and heated[62,64,173] or it may be agitated with a clear lime water[150] or with a suspension of lime in water.[66] Likewise the oil may be filtered through mixtures of lime and sawdust,[71] through lime-treated diatomaceous earth,[46] or through layers of lime and charcoal[154] to which additional layers of wood ashes, elm bark and sand may be added.[127] The lime may also be used in combination with other chemicals like sodium chloride with[107] and without[62] cream of tartar, sodium chloride, sodium hydroxide, alum and manganese compounds,[175] sulfur and ferrous sulfate,[13] ferric oxide,[130] or potassium hydroxide and pyrogallic acid.[66] The main and apparently the only reason of employing lime is the reduction in treating cost. However, these expectations are not always fully realized because the quantity of lime consumed is normally considerably larger than the calculated figure and the refining

problems are often aggravated.

Objections of applying lime to oils arise from the solubility of lime soaps in the oil and emulsification. The much greater solubility of lime soaps in the oil as compared to the similar soaps of sodium or potassium prevents their complete removal by water washing. For this reason the ash



content and some of the other properties of the finished product may show a considerable deterioration. The presence of lime soaps also leads to the formation of the water-in-oil emulsions while soaps of alkali metals produce the oil-in-water emulsions. This increases the difficulty of obtaining satisfactory results in washing the lime treated oils with water in addition to the adverse solubility characteristics of the soaps formed. However, emulsification tendencies may be reduced by employing mixtures of lime and sodium or potassium hydroxides which form emulsions of opposite type and tend to neutralize the effect of each other.

Various suggestions were made to overcome the above objections which include contacting the oil with adsorbents or application of sodium hydroxide solutions after refining with lime but this introduces an additional operation and raises the treating cost. Formation of emulsions may be minimized by using superatmospheric pressure and eliminating the presence of gases and vapors[66] by employing demulsifiers, and by similar methods but this complicates the treating procedure and may lead to undesirable contamination of the product. As a result few, if any, refineries employ lime as a regular treating agent except in extreme emergency when the product quality is of secondary importance and the use of various substitutes may be warranted.[103]

The same considerations apply to the use of calcium carbonate which has additional disadvantages as compared to lime by having lower alkalinity and a much greater tendency of liberating gases during neutralization. However, suggestions were made to apply calcium carbonate or dolomite[49] to gasoline and similar distillates[2] and to reduce the unfavorable effects by washing the treated products with sodium hydroxide solutions.[27]

Barium hydroxide was recommended for precipitating naphthenic acids prior to removing mercaptans with strong sodium hydroxide solutions.[94]

Magnesium hydroxide and brucite in the presence of water[109] to which magnesium sulfate may be added to reduce emulsification[47,106] were suggested for neutralizing acid treated oils. Filtering through magnesium oxide[104] or a mixture of brucite and tripoli[48] may be resorted to. A sweet product can be obtained if sulfur is added to the oil before filtering through brucite.[102] Washing the oil with sodium hydroxide solution after contacting with magnesium oxide[110] may be necessary for the reasons already explained in connection with lime.

Solubility Promoters

Addition of organic solvents to the water solutions of sodium or potassium hydroxides often increases their solvent power toward the mercaptans. Besides the phenolic-compounds previously mentioned many other substances are effective in this respect as shown in Table 1.[102] These solubility promoters are often referred to as solutizers or solventizers. The solubility phenomena involved are complex[120] and not always well understood. Several reactions appear to proceed simultaneously and sometimes in opposite directions as indicated by the presence of distinct minima on many solubility curves.

Regeneration of caustic solutions is done commercially by blowing with steam or air. Air regeneration may be speeded up by adding oxidation promoters to the solutions. Many chemicals were recommended for this purpose as shown in Table 2 and some of them are in common use.

The regenerated caustic solutions have the tendency to emulsify because of gradual accumulation of resinous substances. The useful life of the solutions can be extended by addition of demulsifying agents previously described. However, in many instances the concentration of resinous substances may reach the limit when the

TABLE 1
Solubility Promoters

SUBSTANCE	U.S. Patent	Date	Inventor
Acid Oil	2,315,965	4-20-43	McNamara, T. L. and Henderson, L. M.
Alcohols	2,043,254	6- 9-36	Malisoff, W. M.
Aliphatic or alicyclic dicarboxylic acids	2,229,995	1-28-41	Yabroff, D. L. and White, E. R.
Alkyl glycerol	2,212,107	8-20-40	Yabroff, D. L.
Alkylol amines	2,220,138	11- 5-40	Word, W. R.
Alkyl phenols	2,228,028	1- 7-41	Brower, P. V.
Alkyl phenols and isobutyric acid	2,223,706	12- 3-40	Yabroff, D. L. and White, E. R.
Amines, cresylates and naphthenates	2,373,004	4- 3-45	Ayers, G. W., Jr. and Henderson, L. M.
Aminoalkylamines or alkanolamines	2,152,720	4- 4-39	Yabroff, D. L.
Aminobutylene glycol	2,168,078	8- 1-39	Yabroff, D. L.
Aromatic monocarboxylic acids	2,439,670	4-13-48	Oosterhout, J. C. D.
Butylene glycol	2,152,106	3-28-39	Yabroff, D. L.
Butyric or propionic acid	2,297,737	9-29-42	Craig, W. A. and Rich, P. C.
Carboxy ethers	2,413,933	1- 7-47	Adams, C. E. and Tom, T. B.
Chloroacetic acid	2,312,820	3- 2-43	Henderson, L. M. and Ayers, G. W., Jr.
Chlorophenol, chlorocresol or chlorohydroquinone	2,341,918	2-15-44	Henderson, L. h., Ayers, G. W., Jr. and McNamara, T.L.
Compounds containing amino and hydroxy radicals and oxygen or sulfur	2,186,399	1- 9-40	Yabroff, D. L.
Glutaric acid	2,229,995	1-28-41	Yabroff, D. L. and White, E. R.
Cupal and cresol	2,315,384	3-30-43	Ayers, G. W., Jr., Bond, D. C. and Henderson, L. M.
Cumic acid	2,439,670	4-13-48	Oosterhout, J. C. D.
Diamine alcohols	2,152,723	4- 4-39	Yabroff, D. L.
Ethylene glycol	2,160,632	5-30-39	Yabroff, D. L. and White, E. R.
Ethylene glycol and naphthenic acids	2,316,753	4-20-43	Ayers, G. W., Jr. and Henderson, L. M.
Ethyl thioglycolic acid	2,347,432	4-25-44	Polly, O. L. and Byrns, A. C.
Glycols and naphthenic acids	2,360,537	10-17-44	Ayers, G. W., Jr. and Henderson, L. M.
Hydroxy butyric acid	2,152,722	4- 4-39	Yabroff, D. L. and White, E. R.
Hydroxy valeric acid	2,186,577	5- 2-39	Yabroff, D. L. and White, E. R.
Isobutyric acid	2,149,379	3- 7-39	Yabroff, D. L. and White, E. R.
	2,149,380	3- 7-39	Yabroff, D. L. and White, E. R.
	2,315,706	4- 6-43	Border, L. E.
Methyl cellosolve, naphthenic acids and cresols	2,381,859	8-14-45	Ayers, G. W., Jr. and Henderson, L. M.
Methyl alcohol	2,134,547	10-25-38	Buc, H. E.
Monomethyl glyceryl ether	2,212,106	8-20-40	Yabroff, D. L.
Morpholine	2,343,794	3- 7-44	Paulsen, H. C.
Naphthenic acids and phenols	2,297,621	9-29-42	Henderson, L. M. and Ayers, G. W., Jr.
Nitroparaffins	2,318,495	5- 4-43	Johnstone, W. W.
Oxidation products of petroleum and cresols	2,316,730	4-20-43	Bond, D. C.
Polyether acids	2,426,777	8-19-47	Adams, C. E. and Tom, T. B.
Polyhydroxy biphenyls	2,341,917	2-15-44	Henderson, L. M. and Ayers, G. W., Jr.
Polyphenols	2,413,945	1- 7-47	Bolt, J. A.
Propylene glycol	2,183,801	12-19-39	Yabroff, D. L.
Rosin	1,904,175	4-18-33	Stratford, R. K. and Dunbar, W. P.
Rosin and cresols	2,317,055	4-20-43	Henderson, L. M. and Ayers, G. W., Jr.
Shellac	2,314,919	3-30-43	Bond, D. C., Ayers, G. W., Jr., and Henderson, L. M.
Substituted amino acids	2,427,093	9- 9-47	Adams, C. E. and Tom, T. B.
Tannic acid	2,316,092	4- 6-43	Loyd, V. J.
	2,453,067	11- 2-48	Happel, J. and Cauley, S. P.
Tannic acid and oxygen	2,315,530	4- 6-43	Loyd, V. J.
Tar acids	2,316,965	4-20-43	McNamara, T. L. and Henderson, L. M.
Thioacids of phosphorus	2,318,582	5-11-43	Berger, C. W.
Thiocresols	2,392,536	8-11-42	Henderson, L. M. and Ayers, G. W., Jr.
Thioethers	2,426,776	8-19-47	Adams, C. E. and Tom, T. B.
Triethylene glycol	2,212,105	8-20-40	Yabroff, D. L.
Trimethyl ammonium hydroxide	2,089,079	10-27-36	Yabroff, D. L. and Givens, J. W.
Yucca gum	2,317,056	4-20-43	Henderson, L. M. and Bond, D. C.

TABLE 2
Oxidation Catalysts for Regenerating Spent Caustic Solutions

SUBSTANCES	U.S. Patent	Date	Inventor
Hardwood Tar	2,309,771	2-20-45	Bond, D. C.
Hydroxy aromatic compounds	2,447,051	8-17-48	Bond, D. C. and Russell, N. B.
Lead or tin oxides	2,425,777	8-19-47	Adams, C. E. and Tom, T. B.
Nickel sulfide	1,732,906	10-22-29	Morgen, R. A., Yard, W. S. and Rosenstein, L.
Oxides or hydroxides of copper, silver, zinc, cadmium, mercury, tin, lead, iron, cobalt or chromium	2,267,809	12-30-41	Border, L. E.
Polyphenols	2,413,945	1- 7-47	Bolt, J. A.
Pyrogallol	2,425,414	8-12-47	Bond, D. C.
Sulfinic acids of indigo	2,432,301	12- 9-47	Fetterly, L. C.

solutions must be reconditioned or discarded. Several methods for reconditioning the solutions were suggested. They may be diluted with lime water[32] or hard tap water[31] to precipitate the resinous substances which are removed and the purified solution is reconcentrated without losing the solutizer. The resinous substances may be eliminated by coagulating them with a water-treating sludge.[20] They may be adsorbed on activated carbon[160] or magnesia.[159] The resinous substances tend to concentrate at the interfacial layer forming a stubborn emulsion of oil and water and this layer may be withdrawn and distilled to remove the oil.[209] This destroys the emulsion and the resinous substances precipitate out from the remaining mixture. The spent solutions can be saturated with carbon dioxide to convert the hydroxide to carbonate which breaks the emulsion.[168] The resinous substances are separated and the solution recausticized with lime.

Potassium or sodium hydroxides may be used in preparing the caustic solutions. Advantages of employing potassium hydroxide were previously enumerated. However, if potassium hydroxide is employed care should be exercised to avoid its contamination with even small quantities of sodium hydroxide in order to make full use of the more expensive reagent.

The above shows that the composition of the caustic solution may vary rather widely between the different plants, depending upon the process employed and local conditions. Likewise the regeneration methods and even the manner in which the solubility promoters are applied may vary widely. This will be brought up in the following description of the commercial processes of this type which include the Solutizer process, Tannin-Solutizer process, Mercapsol process and Unisol process.

The typical solution employed in the Solutizer process[28, 29, 119] is prepared from potassium hydroxide and isobutyrate and water. The solution is contacted countercurrently in a packed column with the oil containing mercaptans. The fat solution obtained from this operation is regenerated by blowing with steam at about 270° F. in another column equipped with plates.[217] Condensate from the steam-blowing operation is settled to remove the mercaptans and the water layer is used to dilute the fat solution. The diluted solution is also settled in order to separate the entrained gasoline before it is pumped to the regenerator.[212] For a more complete removal of the entrained oil the diluted solution may be scrubbed with an organic solvent.[210] The recovered oil is combined with the extraction column feed. A suggestion was made to use the total condensate including the mercaptans for regenerating the potassium phosphate solutions employed for hydrogen sulfide removal if the plant is operating both processes.[164] For preserving natural inhibitors in the oil the solutizer solution may contain phenolic substances to establish proper equilibrium conditions and prevent their extraction from the oil by the treating reagent.[215] Precautions may be taken to eliminate oxygen from the feed stock and from the solutizer solution.[126]

The oil entering the system can be

fractionated and the individual fractions treated separately under optimum conditions.[52,53] Suggestions were made to treat the oil with successive portions of the solutizer solution regenerated to different levels.[167] After the solutizer solution is completely exhausted it may be acidified and extracted with kerosine for the recovery of phenols and isobutyric acid. The kerosine is extracted in its turn with a very strong caustic solution which is used for preparing the fresh solutizer solution.[150]

In the Tannin-Solutizer process,[50,91,92,120,162,199] the treating solution is usually prepared by employing phenolic substances extracted from the oil. This establishes the desired equilibrium conditions and prevents excessive loss of natural inhibitors which are preserved in the finished product. Isobutyric acid or its mixtures with phenols may be employed. In addition to the solutizer the treating solution contains a small quantity of tannin. Tannin is used to accelerate oxidation of mercaptides to disulfides in the spent solution which is done by air blowing at 110-130° F. The disulfides formed are separated by settling preferably after mixing the regenerated solution with a small quantity of oil. The loss of tannin catalyst due to oxidation during the air blowing operation is greatly minimized by leaving a small quantity of mercaptans in the regenerated solution (about 0.1-0.3 percent weight) to protect the catalyst.[25,54] Traces of mercaptans that might be left in the oil after this or other extraction process may be converted to disulfides by saturating the extracted product with air and contacting with an additional quantity of the solutizer solution.[27]

The Mercapsol process is similar to the Solutizer process. Tar acids obtained from coking of coal are employed.[141] A typical treating solution contains m- and p-cresols dissolved in the aqueous caustic solution to which methyl cellosolve might be added.[11] The completely spent solution may be acidified and extracted with hexane.[147]

In the Unisol process mercaptans are extracted with sodium hydroxide dissolved in a water-methyl alcohol mixture.[17,34,36,74,127,136,153] The oil free of hydrogen sulfide is introduced at the bottom of the extraction column and the sodium hydroxide solution at the top while methyl alcohol is injected in the middle. The aqueous sodium hydroxide solution removes methyl alcohol from the finished product in the upper part of the column[139] leaving less than 0.004 percent weight of the alcohol in the oil.[136] Mercaptans are extracted in the lower portion of the column where the oil is washed with the sodium hydroxide solution containing methyl alcohol. The spent or fat solution removed from the bottom of the extractor is distilled. The distillation bottoms consisting of sodium hydroxide solution in water and free of methyl alcohol are returned to the top of the extractor while the overhead vapors contain methyl alcohol, mercaptans and steam. After condensation of these vapors two liquid phases are formed.[20] The mercaptan phase is separated from the methyl alcohol-water phase and methyl alcohol is recovered from its water solution by fractionation. Concentration of phenols in the aqueous sodium hydroxide solution is adjusted to leave in the gasoline the desired quantity of these natural inhibitors.

Potassium hydroxide may be employed instead of sodium hydroxide and successive extractions conducted with the caustic-methyl alcohol solutions of continuously decreasing water content.[14] Suggestions were made to use anhydrous methyl alcohol for dissolving caustic used in the last extraction step.[97] A mixture of low and high boiling alcohols may be substituted for the solvents.[13] In the regeneration step extraction of mercaptans from methyl alcohol-water solutions with an immiscible solvent like gasoline was recommended.[37,122] Another suggestion refers to oxidation of mercaptans to disulfides by contacting the methyl alcohol-water-mercaptan vapors with cupric oxide before condensation. The alcohol is then separated from the mercaptans by distillation.[121] Regeneration of spent solutions with air has also been recommended.[212] A special procedure has been worked out for extracting mercaptans from oils with the caustic solution in methyl alcohol-water mixtures when the concentration of mercaptans in the oil is 20-60 percent volume.[70]

A modified process employing potassium hydroxide, methyl alcohol and cresylic acid has been suggested for refining distillate fuel oils.[210]

In the presence of hydrogen peroxide[210] or elemental sulfur[102,103] caustic solutions in methyl alcohol-water mixtures convert mercaptans immediately into disulfides without formation of emulsions thus simplifying the sweetening operation.

BIBLIOGRAPHY

[1] Abeles, V., U. S. Pat. 2,378,382, June 19, 1945.
[2] Albright, J. C., Petroleum Eng. 21 C, No. 4, 32-4 (1949).
[3] Allien, V. S., U. S. Pat. 1,484,167, Feb. 19, 1924.
[4] Amend, O. P., and Macy, J. H., U. S. Pat. 551,941, Dec. 24, 1895.
[5] Angles, L. A., Bol. inform petrol (Buenos Aires) 24,143-56 (1947).
[6] Apger, F. A., U. S. Pat. 2,367,178, Jan. 16, 1945.
[7] Arnold, H. E., U. S. Pat. 1,454,593, May 8, 1923.
[8] Atwood, L., and Atwood, W., U. S. Pat. 15,506, Aug. 12, 1856.
[9] August, J., Jr., U. S. Pat. 2,352,594, July 4, 1944.
[10] Axtell, F. C., U. S. Pat. 1,738,518, Dec. 10, 1929.
[11] Ayers, G. W., Jr., and Henderson, L. M., U. S. Pat. 2,381,859, Aug. 14, 1945.
[12] Bannerot, R. A., U. S. Pat. 2,245,317, June 10, 1941.
[13] Belchetz, A., and Carney, B. R., U. S. Pat. 2,085,523, June 29, 1937.
[14] Bell, R. T., U. S. Pat. 2,430,269, Nov. 4, 1947.
[15] Benedict, W. L., U. S. Pat. 2,297,366, Oct. 6, 1942.
[16] Benedict, W. L., U. S. Pat. 2,317,600, Apr. 27, 1943.
[17] Bent, R. D., and McCullough, J. H., Oil Gas J. 47, No. 19, 95-103 (1948).
[18] Berg, F., U. S. Pat. 623,066, Apr. 11, 1899.
[19] Berger, H. G., Nygaard, E. M., and Angel, H. S., U. S. Pat. 2,357,252, Aug. 29, 1944.
[20] Birkhimer, E. R., and Leum, L. N., U. S. Pat. 2,309,652, Feb. 2, 1942.
[21] Bjerregaard, A. P., U. S. Pat. 1,791,521, Feb. 10, 1931.
[22] Black, J. C., and Low, W. H., U. S. Pat. 1,749,240, Mar. 4, 1930; Black, J. C., and McConnell, J. R., U. S. Pat. 1,759,730, May 20, 1930.
[23] Black, J. C., Rial, W. D., and Howes, R. T., U. S. Pat. 1,592,328, July 13, 1926.
[24] Blair, S. M., Melvill, A. G., Berry, A. G. V., and Banks, B. G., U. S. Pat. 1,933,410, Oct. 31, 1933.
[25] Bolt, J. A., U. S. Pat. 2,413,945, Jan. 7, 1947.
[26] Bond, D. C., Oil Gas J., 44, No. 31, 83-91.
[27] Bond, D. C., U. S. Pat. 2,427,250, Sept. 9, 1947.
[28] Border, L. E., Oil Gas J., 39, No. 10, 36-8, 40 (1940).
[29] Border, L. E., Chem. and Met. Eng., 47, 776-8 (1940).
[30] Border, L. E., U. S. Pat. 2,315,480, Mar. 30, 1943.
[31] Border, L. E., U. S. Pat. 2,337,225, Dec. 21, 1943.
[32] Border, L. E., U. S. Pat. 2,358,619, Sept. 19, 1944.
[33] Borgstrom, P., U. S. Pat. 1,840,268, Jan. 5, 1932.
[34] Brandt, P. L., and Hougen, J. O., Oil Gas J., 37, No. 46, 98-103 (1939).
[35] Branaky, O. E., U. S. Pat. 1,661,657, Aug. 21, 1928.
[36] Brown, K. M., World Petroleum, 18, No. 8, 72-4 (1947).
[37] Brown, K. M., and Gerhold, C. G., U. S. Pat. 2,437,345, Mar. 9, 1948.
[38] Brown, W., U. S. Pat. 10,055, Sept. 27, 1853.
[39] Burgess, L., U. S. Pat. 1,681,895, Aug. 21, 1928.
[40] Burk, R. E., U. S. Pat. 2,009,954, July 30, 1935.
[41] Burk, R. E., U. S. Pat. 2,306,933, Dec. 29, 1942.
[42] Burk, R. E., and Hughes, E. C., U. S. Pat. 2,020,932, Nov. 12, 1935.
[43] Burk, R. E., and Hughes, E. C., U. S. Pat. 2,150,149, Mar. 14, 1939.
[44] Burk, R. E., and Hughes, E. C., U. S. Pat. 2,162,670, June 13, 1939.
[45] Byrns, A. C., U. S. Pat. 2,210,542, Aug. 6, 1940.
[46] Caldwell, L., U. S. Pat. 1,603,314, Oct. 19, 1926.
[47] Caldwell, L., U. S. Pat. 1,921,116, Aug. 8, 1933.
[48] Caldwell, L., U. S. Pat. 1,952,622, Mar. 27, 1934.
[49] Caldwell, L., U. S. Pat. 1,954,116, Apr. 10, 1934.
[50] Camp, E. Q., and Walsh, D. C., U. S. Pat. 2,394,662, Feb. 12, 1946; Cobb, E. B., U. S. Pat. 1,357,224, Nov. 5, 1920.
[51] Cannon, H. H., U. S. Pat. 1,881,044, Oct. 4, 1932.
[52] Caselli, A. V., and Nixon, A. C., U. S. Pat. 2,270,667, Jan. 20, 1942.
[53] Caselli, A. V., and Nixon, A. C., U. S. Pat. 2,258,279, Oct. 7, 1941.
[54] Cauley, S. P., U. S. Pat. 2,446,507, Aug. 3, 1948.
[55] Cauley, S. P., U. S. Pat. 2,455,656, Dec. 7, 1948.
[56] Clancy, J. C., U. S. Pat. 1,423,710, July 25, 1922.
[57] Clancy, J. C., U. S. Pat. 1,423,711, July 25, 1922.
[58] Clancy, J. C., U. S. Pat. 1,423,712, July 25, 1922.
[59] Cobb, E. B., U. S. Pat. 1,357,224, Nov. 2, 1920.
[60] Cobb, E. B., U. S. Pat. 1,357,225, Nov. 2, 1920.

[81] Cobb, E. B., U. S. Pat. 1,413,005, Apr. 18, 1922.

[82] Connelly, J. H., U. S. Pat. 43,760, Aug. 9, 1864.

[83] Connelly, M., U. S. Pat. 240,093, Apr. 12, 1881.

[84] Connelly, M., U. S. Pat. 240,094, Apr. 12, 1881.

[85] Craig, W. A., and Rich, P. C., U. S. Pat. 2,223,170, Nov. 19, 1940.

[86] Crosby, R. H., and Carney, B. R., U. S. Pat. 2,030,245, Feb. 11, 1936.

[87] Day, D. E., U. S. Pat. 1,867,908, July 19, 1932.

[88] Day, D. E., U. S. Pat. 1,902,221, Mar. 21, 1933.

[89] Drennan, H. E., U. S. Pat. 2,048,784, July 28, 1936.

[90] Drennan, H. E., U. S. Pat. 2,452,040, Oct. 26, 1948.

[91] Dubbs, H., U. S. Pat. 161,672, Apr. 6, 1875.

[92] Faber, J. F., Hanna, H. C., and Chappell, M. L., U. S. Pat. 1,562,156, Nov. 17, 1925.

[93] Fetterly, L. C., U. S. Pat. 2,426,087, Aug. 19, 1947.

[94] Field, H. W., Natl. Petroleum News, 33, No. 40, R316-8 (1941); Refiner Natural Gasoline Mfr., 20, 419-21 (1941); Oil Gas J., 40, No. 20, 40-1 (1941).

[95] Fleming, R., U. S. Pat. 1,325,668, Dec. 23, 1919.

[96] Fleury, H., U. S. Pat. 50,571, Oct. 24, 1865.

[97] Fordred, J., U. S. Pat. 54,267, Apr. 24, 1866.

[98] Frolov, B. A., Can. 426,405, Mar. 27, 1945.

[99] Frolov, B. A., U. S. Pat. 2,213,501, Sept. 3, 1940.

[100] Fugua, F. D., Petroleum Processing, 3, 1050-1 (1948).

[101] Garrison, C. W., U. S. Pat. 1,973,895, Sept. 6, 1934.

[102] Gary, W. W., U. S. Pat. 1,833,396, Nov. 24, 1931.

[103] Gesner, A., U. S. Pat. 11,204, June 27, 1854.

[104] Gesner, A., U. S. Pat. 11,205, June 27, 1854.

[105] Goudaire, W., and Stead, G., U. S. Pat. 101,003, Mar. 22, 1870.

[106] Graham, C. B., U. S. Pat. 732,937, July 7, 1903.

[107] Hall, F. W., U. S. Pat. 1,969,694, Aug. 7, 1934.

[108] Halloway, F. A. L., and Wilkes, D. O., U. S. Pat. 2,317,770, Apr. 27, 1943.

[109] Hamilton, T. S., U. S. Pat. 2,355,291, Aug. 8, 1944.

[110] Happel, J., U. S. Pat. 2,366,104, Dec. 26, 1944.

[111] Happel, J., and Cauley, S. P., Ind. Eng. Chem., 39, 1655-9 (1947).

[112] Happel, J., Cauley, S. P., and Kelly, H. S., Oil Gas J., 41, No. 27, 136, 139-42, 147-52 (1942).

[113] Harnsberger, U. S. Pat. 2,364,974, Aug. 1, 1944.

[114] Held, J. B., U. S. Pat. 2,454,383, Nov. 23, 1948.

[115] Heilman, W. O., U. S. Pat. 2,273,104, Feb. 17, 1942; Chaney, L. V., and Schulze, W. A., U. S. Pat. 1,998,863, Apr. 23, 1935.

[116] Heilman, W. O., U. S. Pat. 2,324,927, July 20, 1943.

[117] Henderson, L. M., U. S. Pat. 2,317,052, Apr. 20, 1943.

[118] Henderson, L. M., Ayers, G. W., Jr., and Ridgway, C. M., Oil Gas J., 38, No. 43, 114, 118, 121 (1940).

[119] Hewlett, A. P., U. S. Pat. 2,218,610, Oct. 21, 1940.

[120] Hewlett, A. P., U. S. Pat. 2,316,691, Apr. 13, 1943.

[121] Hewlett, A. P., U. S. Pat. 2,337,467, Dec. 21, 1943.

[122] Hewlett, A. P., and Paulsen, H. C., U. S. Pat. 2,428,623, Oct. 7, 1947.

[123] Higgins, E. C., Jr., and Gardner, F. T., U. S. Pat. 1,977,631, Oct. 23, 1934.

[124] Hood, J. J., and Salamon, A. G., U. S. Pat. 962,840, June 28, 1910.

[125] Hoover, C. O., U. S. Pat. 2,329,615, Sept. 14, 1943.

[126] Hoover, C. O., U. S. Pat. 2,329,616, Sept. 14, 1943.

[127] Horner, E. N., U. S. Pat. 22,727, Jan. 25, 1859.

[128] Howes, R. T., U. S. Pat. 1,968,397, July 31, 1934.

[129] Howes, R. T., U. S. Pat. 2,047,475, July 14, 1936.

[130] Hughes, E. C., U. S. Pat. 2,177,343, Oct. 24, 1939.

[131] Hund, W. J., Thomas, S. B., and Luten, D. B., Jr., U. S. Pat. 2,203,217, June 4, 1940.

[132] Jones, M. C. K., U. S. Pat. 2,420,544, May 13, 1947.

[133] Kalichevsky, V. A., U. S. Pat. 1,695,251, Dec. 11, 1928.

[134] Kalichevsky, V. A., U. S. Pat. 2,028,335, Jan. 21, 1936.

[135] Kalichevsky, V. A., Scafe, E. T., and Hayden, K. F., U. S. Pat. 2,311,593, Feb. 16, 1943.

[136] Kendall, M. T., U. S. Pat. 2,267,109, Dec. 23, 1941.

[137] Kirkpatrick, J. D., U. S. Pat. 74,698, Feb. 18, 1868.

[138] Knottenbelt, H. W., U. S. Pat. 1,277,695, Sept. 3, 1918.

[139] LaCroix, H. N., Natl. Petroleum News, 33, No. 10, R-72-80 (1941).

[139a] LaCroix, H. N., Natl. Petroleum News, 36, No. 9, R-170-1 (1944); World Petroleum, 15, No. 3, 56-7 (1944).

[140] Leum, L. N., U. S. Pat. 2,320,939, June 1, 1943.

[141] Leum, L. N., Birkhimer, E. R., and McCullough, J. H., U. S. Pat. 2,368,931, Feb. 6, 1945.

[142] Levenshtam, M., Azerbaidzanskoe Neftyanoe Khoz. 1939, No. 7, 33-4.

[143] Link, L., and Amos, M. B., U. S. Pat. 1,718,714, June 25, 1929; Schulze, W. A., and Chaney, L. V., U. S. Pat. 2,020,661, Nov. 12, 1935, and U. S. Pat. 2,034,837, Mar. 24, 1936; Burk, R. E., and Hughes, E. C., U. S. Pat. 2,150,149, Mar. 14, 1939.

[144] Loew, O., U. S. Pat. 101,384, Mar. 29, 1870.

[145] Lovell, L., and Martin, A. E., and Bell, F. W., U. S. Pat. 2,346,497, Apr. 11, 1944.

[146] Lowry, C. D., Jr., and Moriarty, F. C., Oil Gas J., 44, No. 26, 105-9 (1945).

[147] Lowry, C. D., Jr., and Sutherland, R. E., U. S. Pat. 2,336,109, Dec. 7, 1943.

[148] Lugo, O., U. S. Pat. 596,410, Dec. 28, 1897.

[149] Lupton, G., U. S. Pat. 110,054, Dec. 13, 1870.

[150] Maitland, H. T., U. S. Pat. 1,605,046, Nov. 2, 1926.

[151] Malishev, B., U. S. Pat. 2,059,459, Nov. 3, 1936.

[152] Mallsoff, W. M., U. S. Pat. 1,899,042, Feb. 28, 1933; Morrell, J. C., U. S. Pat. 1,940,726, Dec. 26, 1933.

[153] Mallsoff, W. M., and Boyd, J. H., Jr., U. S. Pat. 2,094,612, Oct. 5, 1937.

[154] Malson, P. E., U. S. Pat. 2,367,172, Jan. 9, 1945.

[155] Mason, C. F., Bent, R. D., and McCullough, J. H., Proc. Am. Petroleum Inst. 22nd Ann. Meeting, Sect. III, 22, 45-8 (1941).

[156] Mason, A., and Grant, J. B., U. S. Pat. 329,546, Apr. 6, 1886.

[157] McCormick, T. F., and Lazar, A., U. S. Pat. 2,183,968, Dec. 19, 1941.

[158] McCullough, J. H., U. S. Pat. 2,269,467, Jan. 13, 1942.

[159] McGowan, T., U. S. Pat. 257,961, May 16, 1882.

[160] McKusick, B. L., and Alves, H. A., Oil Gas J., 42, No. 49, 126-7, 252, 255 (1944).

[161] McMichael, P., U. S. Pat. 1,603,701, Oct. 19, 1926.

[162] McMichael, P., U. S. Pat. 1,655,066, Jan. 3, 1928.

[163] McMichael, P., U. S. Pat. 1,669,944, May 15, 1928.

[164] McMichael, P., U. S. Pat. 1,655,069, Jan. 3, 1928.

[165] McNamara, T. L., U. S. Pat. 2,335,347, Nov. 30, 1944.

[166] McNamara, T. L., and Henderson, L. M., U. S. Pat. 2,350,176, May 30, 1944.

[167] McOmie, R. W., Davis, O. L., and Nixon, A. C., U. S. Pat. 2,337,262, Dec. 21, 1943.

[168] Merrill, J., U. S. Pat. 43,326, June 28, 1864.

[169] Millochau, A., U. S. Pat., 38,641, May 19, 1863.

[170] Morehouse, C. L., U. S. Pat. 174,291, Mar. 21, 1876.

[171] Moriarty, F. C., Petroleum Eng., 15, No. 7, 150, 152 (1944).

[172] Morrison, C. G., and Rupp, W. H., U. S. Pat. 2,248,109, July 8, 1941.

[173] Nelman, D. S., U. S. Pat. 305,953, Sept. 30, 1884.

[174] Neller, J. R., and Vance, G. M., U. S. Pat. 1,672,621, June 5, 1928.

[175] Neusendorff, J. B., U. S. Pat. 1,666,976, Apr. 24, 1928.

[176] Nixon, A. C., U. S. Pat. 2,305,549, Dec. 15, 1942.

[177] Nixon, A. C., U. S. Pat. 2,379,096, June 26, 1945.

[178] Nixon, A. C., and Davis, O. L., U. S. Pat. 2,305,550, Dec. 15, 1942.

[179] Nixon, A. C., and Davis, O. L., U. S. Pat. 2,331,622, Oct. 12, 1943.

[180] Nixon, A. C., and Yabroff, D. L., U. S. Pat. 2,341,878, Feb. 15, 1944.

[181] Obolentozev, R. D., and Dementieva, M. I., Compt. rend. acad. sci. U. R. S. S., 51, 621-3 (1946).

[182] O'Donnell, J. P., Oil Gas J., 43, No. 5, 45-7 (1944).

[183] Olsen, G. F., U. S. Pat. 1,665,110, Apr. 3, 1928.

[184] Owen, J. J., U. S. Pat. 2,199,204, Apr. 30, 1940.

[185] Paulsen, H. C., U. S. Pat. 2,330,735, Sept. 28, 1943.

[186] Payne, D. E., and Voorhees, V., U. S. Pat. 2,431,770, Dec. 2, 1947.

[187] Pelzer, H. L., U. S. Pat. 1,716,375, June 23, 1929.

[188] Petrov, G. S., U. S. Pat. 1,233,700, July 17, 1917; Chappell, M. L., Ziser, G. J., and Moyer, E. L., U. S. Pat. 1,672,304, June 5, 1928; Neller, J. R., and Vance, G. M., U. S. Pat. 1,672,621, June 5, 1928; Mallsoff, W. M., U. S. Pat. 1,963,542-3, Aug. 7, 1934; Day, C. A., Jr., U. S. Pat. 2,084,575, June 22, 1937; Birkhimer, E. R., U. S. Pat. 2,345,449, Mar. 28, 1944.

[189] Pew, A. E., Jr., U. S. Pat. 2,006,407, July 2, 1935.

[190] Ramage, A. S., U. S. Pat. 1,702,313, Feb. 19, 1929.

[191] Rees, H. V., and Teichmann, C. F., U. S. Pat. 1,895,607, Apr. 17, 1934.

[192] Regan, T. J. F., U. S. Pat. 226,392, June 1, 1880.

[193] Richter, F., U. S. Pat. 1,095,764, June 5, 1914; Lachman, A., U. S. Pat. 1,896,516, Dec. 13, 1932.

[194] Rogers, W. B., U. S. Pat. 60,559, Dec. 18, 1866.

[195] Rosenbaugh, T. W., U. S. Pat. 2,146,352, Feb. 7, 1939.

[196] Rosenbaugh, T. W., U. S. Pat. 2,299,426, Oct. 20, 1942.

[197] Rosenstein, L., U. S. Pat. 1,827,912, Oct. 13, 1931, and U. S. Pat. 1,943,744, Jan. 16, 1934.

[198] Saybolt, G. M., U. S. Pat. 565,039, Aug. 4, 1896.

[199] Saybolt, G. M., U. S. Pat. 565,040, Aug. 4, 1896.

[200] Schalk, E., U. S. Pat. 146,405, Jan. 13, 1874.

[201] Schulze, W. A., U. S. Pat. 1,998,849, Apr. 23, 1935.

[202] Shenderova, M., Azerbaidzhanskoe Neftyanoe Khoz. 1940, No. 2-3, 62-6.

[203] Shiffler, W. H., and Elliott, L. P., U. S. Pat. 2,336,896, Dec. 14, 1943.

[204] Shmidl, A. J., U. S. Pat. 2,347,516, Apr. 25, 1944.

[205] Shtrom, D. A., and Tsyganok, P. I., Vostochnaya Neft. 1939, No. 2, 26-7.

[206] Shemmer, H. T., U. S. Pat. 52,897, Feb. 17, 1866; Rogers, T. M., and Shoemaker, B. H., U. S. Pat. 2,164,665, July 4, 1939.

[207] Smith, C. J., U. S. Pat. 1,942,071, Jan. 2, 1934.

[208] Smith, F. L., U. S. Pat. 2,075,371, Apr. 6, 1937.

[209] Smith, J., U. S. Pat. 1,450,617, Apr. 3, 1923.

[210] Sperling, C. C., U. S. Pat. 2,319,354, May 18, 1943.

[211] Stagner, B. A., Ind. Eng. Chem., 27, 275-7 (1935); Oil Gas J., 33, No. 50, 62-4 (1935).

[212] Stagner, B. A., U. S. Pat. 1,970,583, Aug. 21, 1934.

[213] Stewart-Wallace, J. S., and Cowell, W. B., U. S. Pat. 716,132, Dec. 16, 1902.

[214] Stratford, R. K., and Doohan, W. P., U. S. Pat. 1,954,959, Apr. 17, 1934.

[215] Sylvester, F., U. S. Pat. 66,669, Sept. 10, 1867.

[216] Tatro, J. A., U. S. Pat. 99,728, Feb. 8, 1870.

[217] Tiemann, J. H., U. S. Pat. 321,465, July 7, 1885.

[218] Tuttle, R. B., Oil Gas J., 46, No. 19 54-5, 108-9 (1947).

[219] Vesselovsky, V., and Kalichevsky, V. A., Ind. Eng. Chem., 23, 181-4 (1931); Bierregaard, A. P., U. S. Pat. 1,791,521, Feb. 10, 1931; Wilson, H. H., U. S. Pat. 1,805,444, May 12, 1931; Schuhmann, R., U. S. Pat. 1,935,725, Nov. 21, 1933.

[220] Vesterdal, H. G., U. S. Pat. 2,174,023, Sept. 26, 1939.

[221] Vesterdal, H. G., U. S. Pat. 2,240,727, May 6, 1941.

[222] Vobach, A. C., U. S. Pat. 2,053,753, Sept. 8, 1936.

[223] Violcu, O., Mon. petrole roumain, 44, 459-62 (1943).

[224] Weber, H. C., U. S. Pat. 1,930,216, Oct. 10, 1933.

[225] Weisenberger, P., U. S. Pat. 54,934, May 22, 1866.

[226] Williams, R. Z., U. S. Pat. 2,076,393, Apr. 6, 1937.

[227] Wilson, H. H., U. S. Pat. 1,805,444, May 12, 1931.

[228] Wilson, J. G., U. S. Pat. 2,351,467, June 13, 1944.

[229] Wilson, V. W., U. S. Pat. 2,181,036-7, Nov. 21, 1939.

[230] Windle, G. S., Petroleum Refiner, 23, 41-5 (1944).

[231] Yabroff, D. L., U. S. Pat. 2,152,721, Apr. 4, 1939.

[232] Yabroff, D. L., U. S. Pat. 2,228,295, Jan. 14, 1941.

[233] Yabroff, D. L., and Givens, J. W., U. S. Pat. 2,140,194, Dec. 13, 1938.

[234] Yabroff, D. L., Walters, E. L., Nixon, A. C., and Minor, H. B., Natl. Petroleum News, 32, No. 50, R 445-8 (1940); Oil Gas J., 39, No. 32, 35-6 (1940).

[235] Yabroff, D. L., and White, E. R., Ind. Eng. Chem., 32, 950-3 (1940).

[236] Yabroff, D. L., and White, E. R., U. S. Pat. 2,155,724, Apr. 4, 1939, and U. S. Pat. 2,168,851, Aug. 8, 1939.

[237] Yabroff, D. L., and White, E. R., U. S. Pat. 2,270,491, Jan. 20, 1942.

[238] Yahnke, R. L., Krause, J. H., and Weisemann, G. H., ACS Houston Meeting, Mar. 26-30, 1950.

[239] Young, J., U. S. Pat. 6,833, Mar. 23, 1853.

End of Part VI. Part VII will appear in an early issue.

A System of Process Calculations For Light Hydrocarbons

Part VII.

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ENGINEERS IN OPERATING plants and designers of new units spend much of their time in the calculation of process equipment and schemes. Setting up a processing system is a lengthy computation job. Each equipment item must be evaluated and the over-all results of the proposed process confirmed by calculation. Much trial-and-error work is necessary. Each process detail or operating alternate can be accepted or rejected only after calculations that are often extensive and tedious.

This is the final article of a series devoted to the simplification and standardization of calculation methods for light hydrocarbon processing plants. The author has developed a system which uses printed computation forms to expedite this work. An orderly procedure is achieved and any tendency toward waste motion sharply reduced.

In these articles the principles of process design calculations have been treated in some detail and use of the printed calculation sheets has been demonstrated by the solution of actual problems. While it is certain that such organization cannot replace process know-how and experience, it is equally certain that the intelligent use of these methods can greatly expedite the work of even the most expert process men.

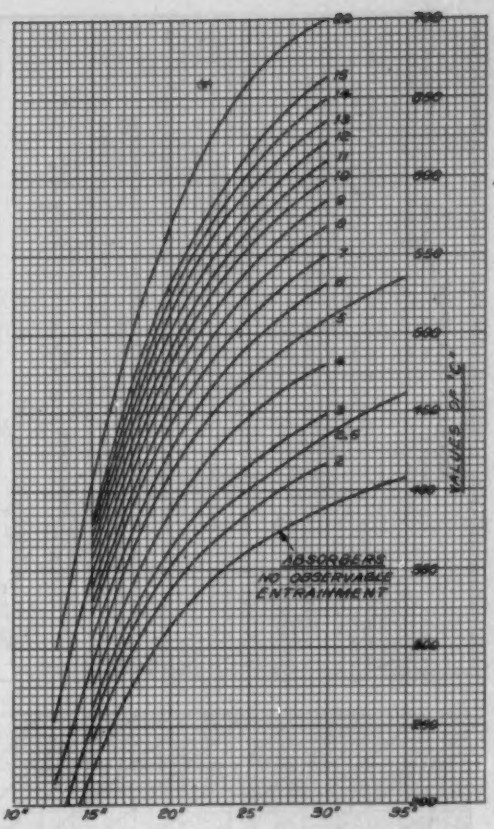

Figure 31
Vapor Capacities of Columns. (See Table A below.)

Column Sizing

THE method of sizing columns is based on the formulas for rate of fall of a small particle in a gas. The minimum diameter of a column for efficient operation must be one in which the rising gas or vapors will not entrain sufficient liquid particles to materially affect the efficiency of the trays. In some equipment, such as absorbers, a small amount of entrainment is very detrimental while considerably more entrainment is permissible in most fractionating and stripping columns.

Tray spacing has a large effect on the capacity of a column. The small particles of liquid or drops thrown up from the surface of the tray have a relatively high velocity. These drops must slow down, stop and settle back against the rising stream of gas or vapor. This means that the effective force of gravity on these drops is the difference between their density and the density of the gas or vapor at column operating conditions of temperature and pressure.

Dr. G. G. Brown has correlated these factors into a simple equation:

Table A
(Read with Figure 31)

Surface Tension Dynes/CM	TRAY SPACING			
	18"	20"	22"	24"
*	288	317	340	356
2	309	339	362	380
2.5	323	355	378	395
3	335	369	392	410
4	356	392	420	439
5	375	414	442	465
6	390	430	460	484
7	405	445	477	500
8	417	460	492	518
9	429	472	507	532
10	440	485	520	545
11	450	495	532	555
12	460	507	542	570
13	469	516	553	582
14	476	524	563	593
15	484	533	574	602
20	516	570	614	646

$V = C [d_2 (d_1 - d_2)]^{1/2}$

* = Absorbers—No observable entrainment
V = Mass Velocity, Lb./Hr. (Ft^2)
d_2 = Vapor Density, Lb./Ft^3
d_1 = Liquid Density, Lb./Ft^3
C = Constant

$$V = C [d_v (d_l - d_v)]^{1/2}$$

V = lbs./hr./sq. feet of vapor
C = Constant depending on tray spacing and surface tension of liquid
d_v = Density of vapor in lbs./cu. feet
d_l = Density of liquid in lbs./cu. feet.

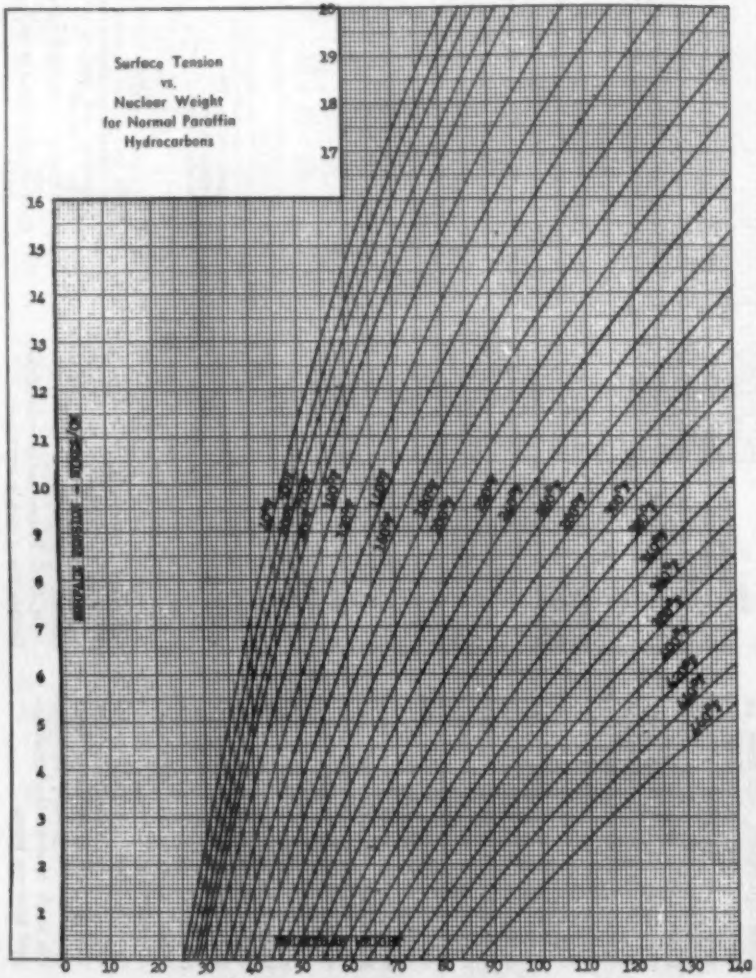

Figure 32

ABSORBER SELECTION

Date:
Rating Sheet
Preliminary
Final
By:—

Inquiry No.
Operating Pressure — Job No.
Outlet Oil Temp. — °F. — Sp. Gr. F.O. at 60° — Sp. Gr. F.O. @ Outlet Oil Temp.
Based on — Process Sheet — By: — Dated:
Main Absorber, Reabsorber or

Composite Gas Sheet	Column		Special Requirements :—
Mol %	Mols	Lbs.	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

$D_1 = \frac{\text{Lbs.}}{\text{Std. Cu. Ft.}} \times \frac{\text{Absolute pressure}}{14.7} \times \frac{520}{460 + \text{F.O. Temp.}} = \frac{\times}{\times\ 14.7 \times (460 +} \times \frac{\times\ 520}{\quad} =$

$D_1 = 62.5 \times$ Sp. Gr. of Oil at F.O. Temp. $= 62.5 \times$ $=$

Tray Spacing " $C =$

Lbs./hr./sq. ft. Column Area $= C\ [D_1\ (D_1 - D_2)]^{\frac{1}{2}} =$ [(—)]$^{\frac{1}{2}} =$

Column Area Required $= \frac{\text{Lbs. Gas}}{92 \times 24 \text{ Lbs./hr./sq. ft.}} = \frac{\quad}{22 \times} =$

Required Column Diameter " ID. Actual Area Sq. Ft.

Tray Spacing " Caps per Tray

No. of Trays (Process Sheet Dated) Std. Drawing No.

Nozzles: Gas In Gas Out Oil In Oil Out

Intercooler Out Intercooler In

Intercooler Locations at Trays Tray Spacing at Intercooler

Design Pressure Design Temperature

Remarks:

Copies to :—	District	Date	Calc. Checked	Date
Copies to :—	Headquarters	Est. Dept.	Calcs. Appd.	Date

Figure 33

STILL SELECTION

Date:
Rating Sheet
Preliminary
Final
By

Inquiry No.
Job No.
Top Temp.
Process Sheet By: Dated:

Operating Pressure
Fat Oil Entering Temp.
Based on
Main Still, Rerun Still, Stripper or

1	2	3	4	5	6	7
Main Rav Still Production	Main Non Condensed	Main Reflux	Total Overhead Mols	Lbs.	Cu Ft.	Gal. Equivalent
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Steam						

$$D_v = \frac{\text{Lbs.}}{\text{Std. Cu. Ft.}} \times \frac{\text{Still Abs. Press.}}{14.7} \times \frac{520}{\text{Still Top Temp.} + 460} = \frac{\quad}{\quad} \times \frac{\quad}{14.7} \times \frac{520}{\quad + 460} = \quad$$

Reflux (Sheet Col.) Sp. Gr. @ 60° F. = Sp. Gr. @

$D_L = 62.5 \times$ Sp. Gr. @ Still Top Temp. $= 62.5 \times$ =

Tray Spacing Fractionating Section " C =

Lbs./hr./sq. ft. column Area = C [D_L (D_V-D_L)] $^{.5}$ = [(—)] $^{.5}$ =

$$\text{Column Area} = \frac{\text{Lbs. Vapors}}{24 \times \text{Lbs./hr./sq. ft.} \times .92} = \frac{\quad}{\quad \times 22} = \quad \text{Sq. Ft.}$$

Required Column Diameter " I.D. Actual Area Sq. Ft.

No. of Fract Trays Tray Spacing Caps per Tray Std. Drawing No.

No. of Stripping Trays " " " " " "

Nozzles: Feed Vapor Out Reflux Reboiler Liquid Out

Water Drawoff Steam

Design Pressure Design Temperature

Remarks:

Copies to :—	District	Date	Calcs. Checked	Date
Copies to :—	Headquarters	Est. Dept.	Calcs. Appd.	Date

Figure 34

FRACTIONATING COLUMN SELECTION

Date:
Rating Sheet
Preliminary
Final
By :—

Inquiry No.
Job No.
Temp.
Based on Process Sheet By: Dated:
Operating Pressure Design Press. Min. Design Temp.
Service Basis on Top Conditions Bottom Conditions

*Total Mols O. H. or from reboiler	*Lbs.	Cu. Ft.	Gal. Equivalent

$$D_v = \frac{\text{Lbs.}}{\text{Cu. Ft.}} \times \frac{\text{Absolute Press.}}{14.7} \times \frac{520}{\text{Temp.} + 460} = \frac{\quad}{\quad} \times \frac{\quad}{14.7} \times \frac{520}{\quad + 460} = \quad$$

Liquid Sp. Gr. @ 60° F. (Sheet) = Sp. Gr. @

$D_L = 62.5 \times$ Sp. Gr. Liquid @ Operating Temp. $= 62.5 \times$ = Lbs./Cu. Ft.

Tray Spacing " Surface Tension Dynes/cm. "C" =

Lbs./hr./sq. ft. = C [D_L (D_V-D_L)] $^{.5}$ = [(—)] $^{.5}$ =

$$\text{Column Area} = \frac{\text{Lbs. Vapors}}{24 \times \text{Lbs./hr./sq. ft.} \times .92} = \frac{\quad}{22} = \quad$$

Required Column Diameter " I.D. Actual Area Sq. Ft.

No. of Fract Trays Tray Spacing Caps per Tray Std. Drawing No.

No. of Stripping Trays Tray Spacing Caps per Tray Std. Drawing No.

Nozzles: Feed Reflux Vapors at Top Vapors from Reboiler

Liquid to Reboiler

Feed Location Above Trays

Thermowell Conns.

Pressure Gauge Conns.

Remarks:

Copies to :—	District	Date	Calc. Checked	Date
Copies to :—	Headquarters	Est. Dept.	Calcs. Appd.	Date

Figure 35

HEAT EXCHANGER SPECIFICATIONS

Figure 36 (Upper left)

CENTRIFUGAL PUMP SPECIFICATIONS

Figure 37 (Upper right)

Surface tension affects the size of the drops of liquid, the lower the surface tension, the smaller the drops and the lower their "settling rate," or the vapor or gas velocity against which they will return to the tray.

Figure 31 shows value of C for different tray spacings and various liquid surface tensions. It will be noted that the value for C for absorbers is based on a surface tension of one dyne. This is an arbitrary value used to minimize entrainment and "carry over" from the absorber.

Figure 32 shows the surface tension of hydrocarbon mixtures of various mol weights and at different temperatures.

Figures 33, 34, and 35 are forms suitable for rating absorbers, stills, and fractionating columns. It is to be noted that the maximum load on a fractionating column can be either in the top section or the bottom section so both these points should be checked. In a fractionating column it is often possible to equalize the load by proper adjustment of feed temperature and in any column where either the top or bottom of the column has a high relative load the possibility of correcting by feed temperature adjustment should be investigated.

Heat Exchanger and Pump Specifications Form

Forms 36, 37 and 38 shows a convenient method of making up inquiries for quotations on heat exchangers, centrifugal and reciprocating pumps.

These forms also give a convenient record of the requirements of the equipment on the basis of the original design, making it easier to check at a later date if the equipment is to be used in other service.

RECIPROCATING PUMP SPECIFICATIONS

Figure 38

These forms only contain the information most generally needed and can be supplemented with additional detailed specifications as to types of material and mechanical requirements when desired.

End of Part VII and Series

THERMOCHEMISTRY for the Petrochemical Industry

Part XV—Curve Fitting: A Method for Minimum Percentage Deviation

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BY THE AUTHOR'S statement, this article on curve fitting is in a sense a companion article to that of George H. Hanson given in Petroleum Refiner in July, 1947, page 83. The article considers the methods used in selecting equation types to closely coincide with given sets of experimental data and methods for determining the empirical constants that apply. The method presented is direct and the possibility of the occurrence of large percentage deviations is a minimum.

AS SCIENTIFIC and technical investigations are so often concerned with the measurement of two or more related quantities, a problem arising constantly in engineering practice is that of fitting an empirical equation to a series of experimental data points. Since the purpose of such an equation is to facilitate the rapid use of the data and to permit interpolation to values not measured in the initial experiment, the obvious aim is to obtain an equation that is simple in form yet that will fit the selected data points to a high degree of accuracy. While it is quite easy to draw a relatively smooth line through the points when plotted on ordinary graph paper, it is often impossible to represent this line exactly by an algebraic equation. However, it is possible to obtain several different types of equations that will fit the given data approximately.

The best form for the empirical equation is often suggested by theoretical considerations. If this is not the case, a rough plot of the data will often help in making the selection. As simplicity and ease of use are two of the most important qualifications, a simple approximate equation is often used rather than a more complicated but more exact one. If there are n sets of observed values, then theoretically at least, it is possible to fit the given data with an equation that involves n arbitrary constants. For example, a polynomial of degree $n - 1$ could be written that would pass exactly through all of the observed values. However, as such an equation would generally be so tedious to use that it would be of little value for rapid engineering work, some sort of compromise must be reached between simplicity and accuracy of the type of equation to be used. For this reason one of the most popular types is a polynomial of rather low degree.

After the form of equation has been selected, the question then arises as to the best method of determining the empirical constants or parameters. There are various methods in common use today, varying somewhat in the resulting accuracy and in the amount of detail required in their application. However, most of these are set up with the purpose of requiring that the absolute values of the deviation of the observed values from the derived curve be small. As engineering work is often more interested in relative than in absolute error, the purpose of this article is to present a method of curve fitting that will yield a minimum percentage deviation.

Methods of Curve Fitting in Common Usage

In some cases a graph may be used to determine the empirical constants in the desired equation. In particular, if the equation is linear, it is necessary only to determine the slope and intercept of the curve. However, for most cases and in particular for more exact work, numerical methods are preferred. The three methods most often used are the method of selected points, the method of averages, and the method of least squares.

When fitting an n parameter curve by the method of selected points, the best or most typical n data values are substituted into the general form of the equation desired. This gives n equations in n unknowns that may be solved for the empirical constants. The resulting constants will vary slightly with different choices of the typical data.

The method of averages differs from the method of selected points in that it makes use of all the observed values. If the curve to be used is a general polynomial of the *nth* degree, the data points are divided into a number of groups equal to the number of unknown parameters. The equations in each group are added, thus giving a set of simultaneous equations equal in number to the number of unknowns. This method is subject to the disadvantage that different groupings of the data points will give different values of the constants.

The method of least squares has for years been the classical device for fitting a curve of given form to a series of observed values. For the form desired, this method produces the equation for which the sum of the squares of the deviations is a minimum. An advantage of this method lies in the fact that the square of an error is a measure of its probability of occurrence. Thus the minimizing of the sum of the squares of the deviations is an assurance that their possibility of existence is a minimum. The theory of this method may be found in numerous books of applied mathematics such as those by Sokolnikoff[7] and Margenau and Murphy.[6] For practical applications, Hanson[3] has published a catalogue of determinants arising often in the least squares procedure and has illustrated their use as applied to the catalytic dehydrogenation of butane. Ferguson[2] has shown the application of the method to the exponential back-pressure curve of gas reserves.

As long as the absolute value of the deviation of the equation from the experimental values is of chief interest, the method of least squares is probably the best method to use for fitting the curve. However, as the technical man if often more concerned with relative or percentage error than with absolute error, it is of interest to examine the method as to relative deviation permitted. If the dependent variable is of the same order of magnitude over the entire range under consideration, then the percentage deviation will also re-

main ot somewhat constant order of magnitude over the same range. However, in many cases the dependent variable may vary as much as three- or four-fold. It is easily seen that in such cases, a given absolute deviation will give a greater percentage deviation at the lower end of the curve than at the higher.

In the past, equations have been derived striving for a minimum percentage deviation by various methods of successive approximations. A method used with considerable success by the author[4] has been to derive an initial curve by the method of selected points. The deviations obtained using this equation are calculated and a plot made of percentage deviation against the independent variable. This curve is then used as a guide in improving the original equation. This process is continued until a favorable balance is obtained between maximum percentage deviation and average percentage deviation.

Direct Approach to Minimum Percentage Deviation

In order to approach directly the problem of fitting a curve for a minimum of percentage deviation, use is made of a similar procedure to that for developing the regular least squares method. Assuming the equation sought to be of a form which expresses the dependent variable as an explicit function of a general polynomial of degree n,

$$y = a_0 + a_1x + a_2x^2 + \ldots\ldots + a_nx^n, \quad (1)$$

then letting y_e stand for the observed values of the dependent variable,

$$\frac{y_e - (a_0 + a_1x + a_2x^2 + \ldots\ldots + a_nx^n)}{y_e} \quad (2)$$

is taken as the fraction deviation. It is desired that the sum of the squares of these fraction deviations be as small as possible in order that the equation will fit the observed data to a high degree of accuracy. This minimization may be accomplished by taking partial derivatives of such a sum with respect to each of the empirical constants and equating the quantities so obtained to zero. In this manner $n + 1$ equations containing the $n + 1$ empirical constants as unknowns are obtained. These are the so-called normal equations and may be solved by any of the regular methods of solving simultaneous linear equations.

$$a_0\Sigma 1/y^2 + a_1\Sigma x/y^2 + \ldots\ldots + a_n\Sigma x^n/y^2 = \Sigma 1/y$$
$$a_0\Sigma x/y^2 + a_1\Sigma x^2/y^2 + \ldots\ldots + a_n\Sigma x^{n+1}/y^2 = \Sigma x/y$$
$$a_0\Sigma x^2/y^2 + a_1\Sigma x^3/y^2 + \ldots\ldots + a_n\Sigma x^{n+2}/y^2 = \Sigma x^2/y$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$a_0\Sigma x^n/y^2 + a_1\Sigma x^{n+1}/y^2 + \ldots\ldots + a_n\Sigma x^{2n}/y^2 = \Sigma x^n/y \quad (3)$$

It is of considerable interest to note that the determinant formed from the coefficients of the unknowns of these equations is symmetrical with respect to its main diagonal (from upper left to lower right). The use of Crout's method[1] will save considerable time in the solving of such sets of equations.

Example

Because of the large range covered by values of the heat capacity of cyclohexane, 22.82 to 88.1, over the temperature range from 0° to 1200° C,[5] this example will serve to demonstrate the utility of the method.

TABLE 1
Heat Capacities of Cyclohexane

T	C_p	T	C_p
0	22.82	700	74.96
100	33.10	800	78.4
200	42.98	900	81.5
300	51.71	1000	84.1
400	59.10	1100	86.3
500	65.28	1200	88.1
600	70.45		

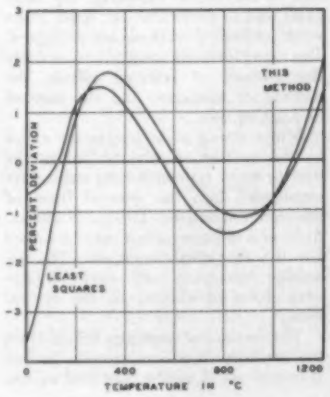
Assuming the equation sought to be a second degree polynomial and making use of the method of least squares, the following equation is obtained:

$$C_p = 23.641 + (10.308 \times 10^{-2})\,T - (4.196 \times 10^{-4})\,T^2$$

Maximum percent deviation = 3.60%
Average percent deviation = 1.18%

The percentage deviations obtained using this equation are plotted in Figure 1. It is seen that the curve is of much greater reliability for higher values of temperature and heat capacity than it is for lower values. For example, if only that portion of the curve between 0° and 600° C is considered, the average error is 1.46 percent rather than the 1.18 indicated.

Figure 1. Percentage Deviation for Heat Capacity Equation of Cyclohexane.



For comparison, by use of equations (3), the following equation is obtained:

$$C_p = 22.976 + (10.660 \times 10^{-2})\,T - (4.482 \times 10^{-4})\,T^2 \quad (5)$$

Maximum percent deviation = 1.98%
Average percent deviation = 0.97%

Not only does this equation give smaller maximum and average percentage deviations than does the equation derived by the regular least squares method, but from Figure 1 it is seen that it is of approximately equal reliability over the entire range of the curve.

If cubic equations are desired to represent the same data, the following results are obtained:

Least squares

$$C_p = 22.486 + (11.760 \times 10^{-2})\,T - (7.346 \times 10^{-4})\,T^2 + (1.750 \times 10^{-6})\,T^3 \quad (6)$$

Maximum percent error = 1.46%
Average percent error = 0.36%

This method

$$C_p = 22.696 + (11.477 \times 10^{-2})\,T - (6.731 \times 10^{-4})\,T^2 + (1.410 \times 10^{-6})\,T^3$$

Maximum percent error = 1.25%
Axerage percent error = 0.38%

The maximum percentage error permitted is again considerably smaller, while the average percentage error is only slightly larger using this method. If a check is made of the lower half of the curve, it is found that the average percent error for the least squares equation is 0.59 percent and that for the equation obtained by the method of this paper is 0.39 percent.

Conclusion

The method of curve fitting as presented here is a direct and certain method of producing the equation of a given form for which the possibility of the occurrence of large percentage deviations from the observed values is a minimum. The curve as derived will be of the same order of reliability over its entire range.

LITERATURE CITED

[1] Crout, Preston D. "A Short Method for Evaluating Determinants and Solving Systems of Linear Equations with Real or Complex Coefficients." Trans. Am. Inst. Elec. Engrs., **60**, 1235-40 (1941).

[2] Ferguson, J. W. "A Critical Analysis of the Application of the Back-Pressure Method in Studies of Gas Reserves." Petroleum Engr., **13**, No. 2, 50-58 (1941).

[3] Hanson, G. H. "Curve Fitting and Surface Fitting. Method of Least Squares." Petroleum Refiner, **26**, No. 7, 83-85 (1947).

[4] Kobe, K. A. "Thermochemistry for the Petroleum Industry. Part I.—Introduction." Petroleum Refiner, **28**, No. 1, 83-87 (1949).

[5] Kobe, K. A., and Long, E. G. "Thermochemistry for the Petrochemical Industry. Part IV.—Cycloparaffinic Hydrocarbons." Petroleum Refiner, **25**, No. 5, 161-163 (1939).

[6] Margenau, H., and Murphy, G. M. *The Mathematics of Physics and Chemistry*, pp. 500-502, New York, D. Van Nostrand Co., Inc., 1948.

[7] Sokolnikoff, I. S. and Sokolnikoff, E. S. *Higher Mathematics for Engineers and Physicists*, pp. 536-544, New York, McGraw-Hill Book Co., Inc., 1941.

HEAVY investments are required to provide adequate storage facilities in refineries and related plants. The value of the stocks and products handled by such tanks is great. Because of these investment factors, it is important that tanks be installed and maintained so that the life of the tank will reach its maximum and so that the tank contents will be protected against losses.

Adequate foundations are a first requirement for satisfactory tank service. This article discusses some of the mistakes that can be made through the installation of storage tanks on poor foundations, and outlines foundation requirements for satisfactory service. This copyrighted story was published in "The Water Tower" for March, 1951, and now appears in Petroleum Refiner with permission of Chicago Bridge & Iron Company because the subject is of high importance to process plant men.

Four Large Oil Storage Tanks at the Stanolind Pipe Line Company Station near Washington, Kan. The two painted tanks have welded steel cone roofs. The two tanks in upper left hand corner are equipped with pan-type floating roofs, the two in the foreground (112,000 barrels each) with double-deck floating roofs.

Adequate Foundations Are First Requirement for Good Tank Service

IRVING E. BOBERG

Chief Engineer, Chicago Bridge & Iron Company, Chicago

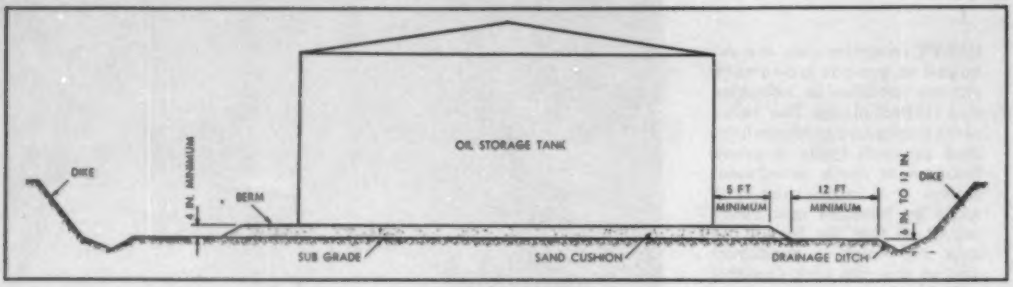
TOO often the importance of foundations is underestimated. Since the flat bottomed oil tank is one of the simplest types of structure and has sufficient flexibility to accommodate appreciable changes in shape, the foundation on which it rests is frequently given little consideration.

With the advent of larger and higher tanks, the effects of poor foundations were multiplied. The larger tank not only imposes a heavier load and hence causes greater settlements, but the distortion caused by any given settlement is, in some measure, proportional to the size of the tank.

In addition, the floating roof user has become increasingly conscious of the importance of a shoe-to-shell fit that is as nearly perfect as possible. It must be obvious that perfection can best be attained if the tank shell is built circular and remains circular within reasonable limits.

If the grade is not level in the beginning, or if it later settles unevenly, the tank will inevitably have a distorted shell. Often the tank builder is blamed for a poor shell that should properly be charged to a poor foundation. In order to obtain good tanks, good foundations must be provided.

Proper grade preparation can also



TYPICAL TANK GRADE

Before placing sand cushion, all loam or other organic material should be removed from the original surface and replaced with well-rolled fill. Frequently the entire area is stripped and the strippings used in constructing the firewall. Berm should be protected against weather with trap rock, gravel or asphalt flashing.

have an important bearing on bottom corrosion. Tanks erected on poorly drained grades, directly contacting corrosive soils, or on heterogeneous mixtures of different types of soils, are all subject to electrolytic attack on the bottom side.

There is no rule of thumb that can be applied to all situations. Each case must be evaluated on the basis of conditions as they exist. Local conditions vary so widely that it would be impossible to anticipate them all. An attempt has been made in the material that follows to deal with the more common aspects of tank foundation design.

In selecting the proper type of foundation, the bearing power of the soil is the primary factor. Where no previous experience in the same area is available, soil borings to determine existing conditions are usually cheap insurance against future trouble. We have seen a number of instances where tank sites were judged solely from surface conditions only to have the empty tanks settle so seriously during construction that the water test could not be performed until the foundation was rectified. With the tanks already erected, this could only be accomplished at great expense.

We know of one instance where a tank settled under water test to such an extent that it collapsed.

While these are extremes, they serve to illustrate the importance of first knowing the nature of the foundation base. Knowledge of geological formation or experience with other heavy structures in the same vicinity will often suffice, but if such knowledge is absent, soil borings are the safest means of investigation. There are many firms over the country well skilled in the art of making such borings. Soil bearing tests are now generally conceded to have little value other than to evaluate conditions at the tested level. The depth to which an applied load will produce significant stresses is in some measure proportional to the size of the loaded area. A large tank fully loaded will probe out weaknesses never revealed by a test on one or two square feet.

Frequently the result of borings will indicate the desirability of limiting tank height rather than the expense of costly foundations.

Assuming that bearing conditions have been determined to be adequate, the simplest form of foundation is a sand pad laid directly on the earth. All loam or organic material should be removed and replaced with suitable material, well compacted. Often a satisfactory fill material is available at the site. If not, bank run gravel is excellent and is readily compacted.

The grade for the tank should preferably be elevated slightly above the surrounding terrain to insure drainage. Sufficient berm should be provided to prevent washing and weathering under the tank shell. The berm width should be at least 5 feet. Weathering can be minimized if the berm is subsequently protected with trap rock, gravel, or an asphaltic flashing.

It is customary to provide a crown of about one inch for each ten feet of radius. On large tanks, the crown is sometimes limited to six inches.

The sand pad should be at least four inches deep. The sand should be clean and free from corrosive elements. Care should be taken to exclude clay or lumps of earth from coming into contact with the bottom. Frequently the difference in potential between two types of earth will set up an electrolytic cell with resultant pitting.

Sometimes crushed rock is substituted for sand, but sand is easier to grade and usually more available.

While there is some difference of opinion, it is considered desirable to oil a sand grade. It is not satisfactory to merely pour oil on the surface because it will not penetrate or mix with the sand. Subsequent laying of the bottom will be difficult and welding is likely to start a fire. Oil and sand should be thoroughly mixed either in a concrete mixer or by "windrowing" with a grader or by hand. Only sufficient oil should be used to thoroughly wet the sand. Excess free oil will make subsequent working on the grade both difficult and hazardous.

If the sand cushion is placed on top of crushed rock fill, the rock should be carefully graded from coarse at the bottom to fine at the top. If this is not done, the sand will percolate down through the voids in the coarser rock.

An excellent base can also be obtained by substituting about 1½ inches of asphalt road paving mix for the sand cushion. This material is available from ready mix plants in many sections of the country. There is one precaution that must be carefully watched. After the material has set up, it is difficult if not impossible for the tank builder to correct inaccuracies by taking down the high and filling in the low spots. It is, therefore, most important that a paved tank grade be levelled with extreme accuracy under the shell.

Drainage is important both from the standpoint of soil stability and bottom corrosion. Good drainage should be provided not only under the tank itself, but the general area should preferably be well drained. Where the terrain does not afford natural drainage, proper ditching around a group of tanks may help to correct the deficiency.

Where suitable bearing soil is not available at the surface, but is available a reasonable distance below the surface, a ring wall foundation is indicated. The purpose of the ring is to confine the soil and prevent lateral movement. The ring wall is founded in the firm stratum and confines the weaker materials. Totally inadequate material should be removed and replaced with well compacted fill.

Many tank owners use ring wall construction as standard even when soil conditions do not indicate its use. There are a number of advantages in

this practice that may well compensate for the added cost. The incidental advantages of the ring wall are neat appearance, an excellent foundation for the tank shell, the elimination of washing and weathering of berms, and the exclusion of surface water running into the grade.

We recommend that ring walls be so proportioned that the unit soil bearing at the level of the bottom of the wall is the same under the concrete as under the confined soil. This can be accomplished and will encourage uniform settlement of the foundation as a whole.

Assuming the tank shell to be centered on the wall, and earth to weigh 100 pounds and concrete 140 pounds per cubic foot, the thickness of the concrete wall may be determined from the following formula:

$$\text{Thickness of wall in inches} = \frac{24\,W}{qH - 80h}$$

Where

W = weight of metal in shell and roof supported on the ring wall in pounds per foot of circumference.

H = height of tank shell in feet.

h = height of ring wall in feet.

q = weight of stored product pounds per cubic foot.

In no case should the ring wall be less than 8 inches thick.

On tanks of relatively small diameter, the above formula will result in ring walls less than eight inches thick, in which case the eight-inch minimum should be used as the closest approach to the desired ideal.

Where a ring wall is used, it should be reinforced circumferentially to resist the hoop stress resulting from lateral pressure of the confined earth. Because soil conditions are rarely known in advance, it is our practice to design such walls on the basis of a lateral pressure equal to 0.3 of the combined liquid and earth vertical pressure. For shallow rings the vertical load contributed by the earth is small, but on deep walls it can become important.

If there are openings in the wall, the reinforcing must be carried around such openings to preserve the continuity of the hoop action. Nominal vertical steel is normally provided primarily for convenience in placing hoop steel.

Through the years there has been considerable discussion of the merits of placing the tank shell on the concrete versus placing the tank entirely within the ring wall. For many years we contended that the tank should not rest on the wall. It was feared that if settlement was greater within the wall than under the wall, failure of the bottom could occur.

On a carelessly prepared grade, this could happen and has happened. It has been our observation, however, that hundreds, if not thousands, of tanks have been successfully erected on ring walls. There are distinct advantages to so doing. It gives the erector a better base on which to build and there is less danger of subsequent shell settlement and distortion. The ring wall is not only founded on better soil than exists near the surface, but there is no danger of erosion under the shell.

We have, therefore, changed our opinion and now recommend ring wall construction with the tank shell resting on the wall, provided the following precautions are taken:

1) Proportion the ring wall so that soil pressures under the entire tank and wall are equal at the level of the wall base. The base of the wall should be below frost line.

2) Pour the ring wall against undisturbed earth without forms if possible. If this is not possible, see to it that backfill both inside and outside of the wall is thoroughly tamped in place. This is particularly important during cold weather when fill material may be frozen. If this is not conscientiously done inside the wall, serious settlement along the wall can damage the bottom.

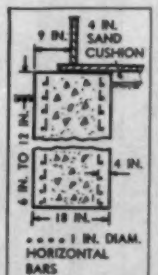
3) The top of the ring wall must be level. This point is frequently overlooked. It is not generally realized what large shell deformations can arise from relatively small differences in ring wall elevation. If the wall is out of level, the erector has no choice other than to erect on shims which involves the placing and maintenance of grout. Experience has shown that it is possible to insist on and obtain accurately levelled walls. A desirable criterion is that the wall shall be level within ¼ inch (plus or minus ⅛ inch) in one plate length (about 34 feet), and that no two points on the wall shall differ in elevation by more than ½ inch (plus or minus ¼ inch). This may sound unduly restrictive, but it can be attained and will pay dividends.

In some cases, several layers of heavy asphalt felt roofing are placed on top of the ring wall under the edge of the tank. This practice has merit in that it seals off the periphery. The bottom joint breakdowns or backup strips settle into the felt and thus the effect of point bearing at bottom joints is minimized.

There are, of course, many pitfalls to be avoided in grade construction. If possible, always avoid situations where a tank rests partly on cut and partly on fill. If it cannot be avoided, see to it that the fill is of a readily compactible material and that it is well compacted. Be sure the fill is retained against lateral movement either by an adequate berm or a concrete ring.

The same caution applies to locations where rock occurs near the surface. Be sure the rock is under the entire tank and that the earth overburden is reasonably uniform in depth. Frequently rock strata will end abruptly and a good criterion is to locate tanks so they are entirely over rock, or entirely off of rock.

Where soil conditions are such that none of the simpler foundation types are adaptable, piled foundations or other special types will require individual consideration for each case.



Design of Ring Wall for 150 Feet Diameter by 48 Feet Floating Roof Tank Storing Gasoline

W = steel weight on wall = 1320 pounds per foot

H = height of shell = 48 feet

h = height of ring wall = 5 feet (assumed 4 feet frost line and 1 foot above grade)

q = weight of stored product = 45 pounds per cubic foot

$T \text{ (thickness of wall)} = \frac{24W}{qH - 80h} = 18 \text{ inches}$

Horizontal pressure on ring $= 5 \times 0.3\,[(62.5 \times 48) + (100 \times 2.5)] = 4875$ pounds per foot of wall

Total hoop tension $= PR = 4875 \times 75 = 366000$ pounds

Required area of hoop steel $= \frac{366000}{20000} = 18.3$ square inches

Use 24 bars 1 inch diameter

NOTES

Ring wall to be founded below frost line.

Note that weight of stored product was used in determining T, whereas weight of water was used in determining reinforcing steel. It is believed that settlement is a factor of time as well as loading, and that in most cases the long term loading is more significant than the temporary water load under test. On the other hand the hoop tension due to water test load must be taken into account to avoid cracking of wall.

Where the characteristics of the confined soil are known, the designer should use the correct ratio between vertical and horizontal pressures rather than the safe limit of 0.3 used above.

For the shallow wall illustrated, the hoop tension was assumed uniform from top to bottom of wall. For high walls, the increase in lateral pressure with depth would require closer steel spacing at the bottom than at the top.

New British American Refinery Is Complete Combination Plant

PROBABLY the world's most advanced example of combination processing is currently being erected for the British American Oil Company, Ltd. at Edmonton, Alberta, by The Canadian Kellogg Company, Ltd., according to the designers, The M. W. Kellogg Company, engineers of Jersey City, N. J.

The refinery, pictured in the perspective drawing, is a complete combination plant operating off one central control room. Processing equipment includes crude distillation, delayed coking, thermal and Fluid catalytic cracking, gasoline stabilizing, light ends fractionating and light oils treating. The first of its kind, this refinery each year will process 2 million barrels of crude brought from Redwater by pipe line.

Key to the processing sequence, according to Kellogg engineers, lies in the segregation of light and heavy feeds stock for thermal and catalytic cracking, respectively. This operation is handled in a unique combination bubble tower **(see arrow)** which fractionates effluent from both the thermal cracker and the delayed coker as well as light cycle oil from the Fluid cat.

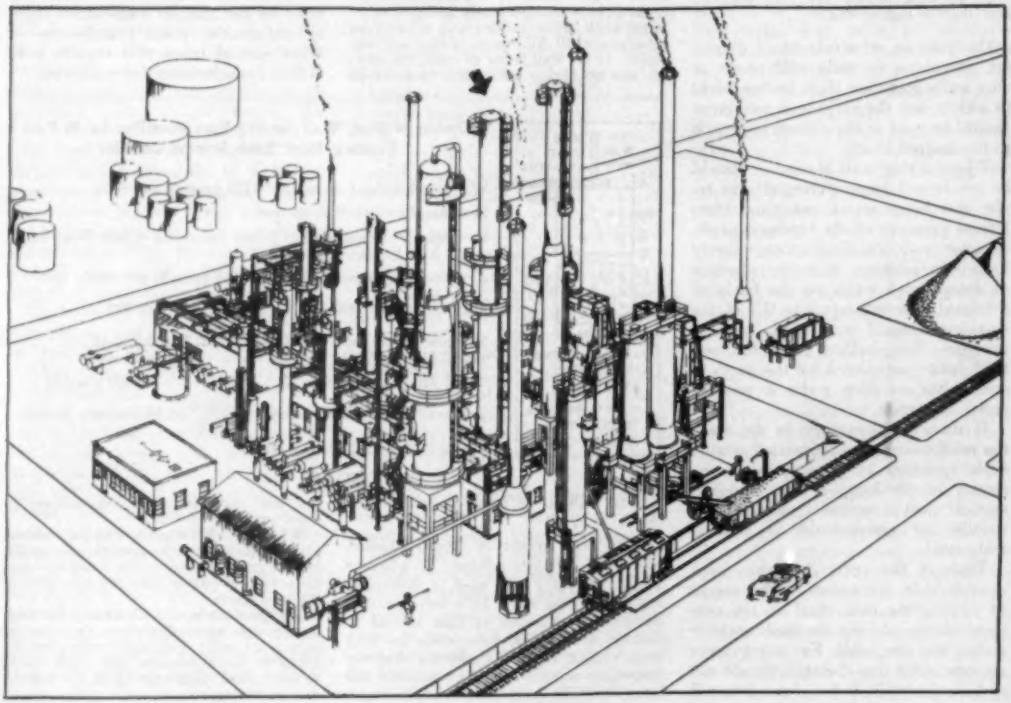
Light ends off the top of this tower go to the vapor recovery group which processes all refinery gaseous products. The overhead liquid product is a blend of coker and thermally cracked gasoline which is stabilized separately from the catalytically cracked gasoline. A mixture of light cycle oil from the cat and light gas oil from the coker is withdrawn from the upper section for thermal cracker feed stock. Below this, heavy gas oil is taken off as cat cracker feed. The bottom product is tar.

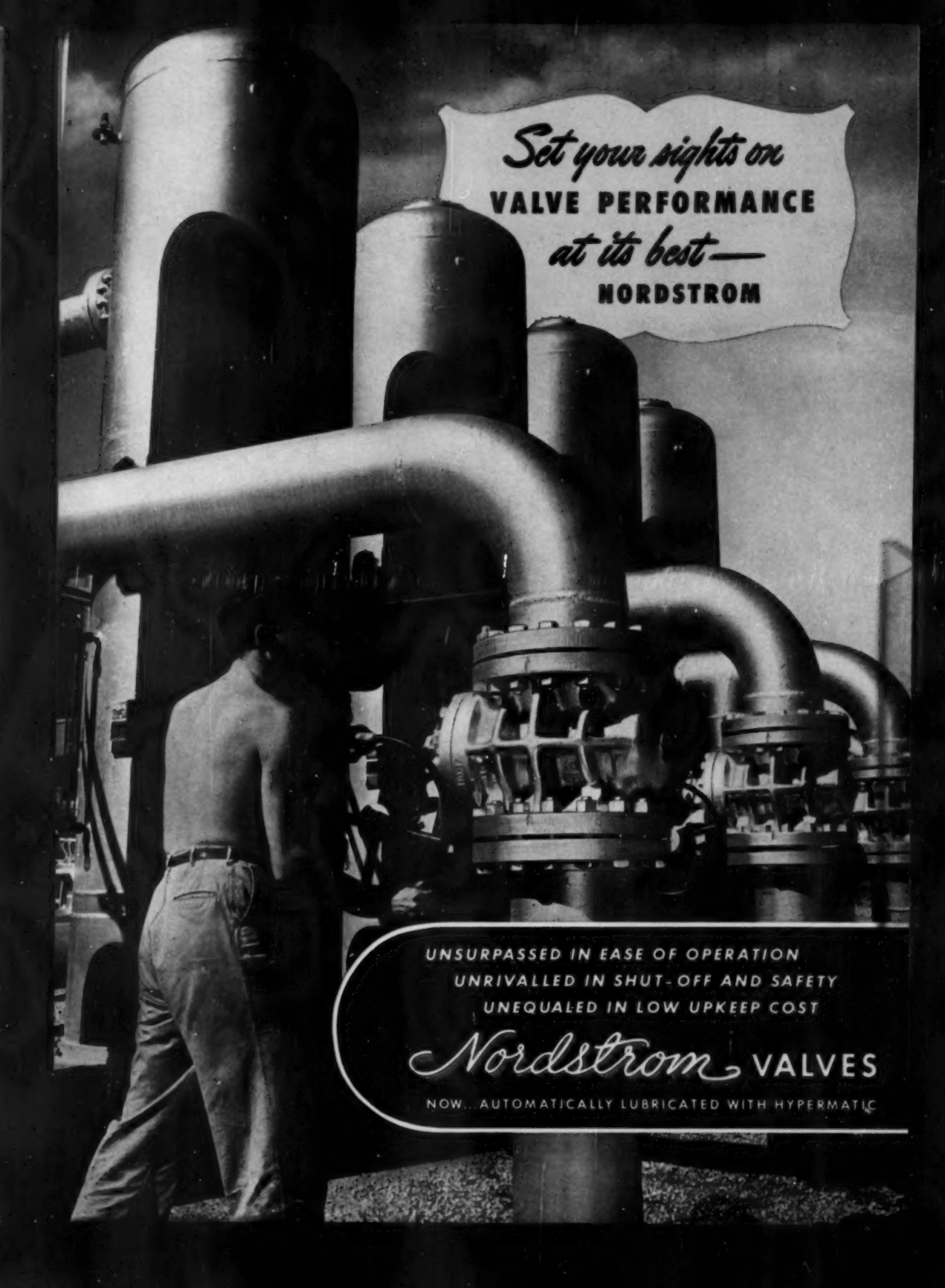
Principal products, therefore, from the refinery are straight-run gasoline from the crude unit, a mixture of coker and thermally cracked gasoline from the combination tower, and catalytically cracked gasoline from the cat fractionator. These gasoline streams are separately stabilized and then blended in whatever proportions are indicated by the market. Seasonal vapor pressure requirements are fulfilled in the final step.

Main advantages of this type of combination processing, according to Kellogg, are found in the reduction in number of individual towers for fractionating the products from each unit process, and savings in tankage for intermediate storage. Since the refinery is designed for continuous processing of the stream, intermediate product storage is minimized.

Of secondary importance, during the cold Canadian winters, is the fact that heating requirements are reduced to a minimum. Oil products lose only a negligible amount of heat during continuous processing. In instances where intermediate storage is needed at a refinery, process heat is lost through the necessity of cooling intermediates for storage.

Perspective Drawing of Complete Combination Plant Being Erected at Edmonton, Alberta, Canada, for British American Oil Company.

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THE SUREST WAY TO KEEP UPKEEP DOWN

A typical installation of Nordstrom valves on gas lines in a terminal and distribution station.

20-year average OF NORDSTROM PARTS REPLACEMENTS

less than ½ of 1% of valve purchases

In a recent audit of sales of Nordstrom valves extending back over a period of 20 years it was found that the ratio of repair and replacement parts was less than ½ to 100. Replacement parts were principally for valves in highly erosive services and for high temperatures where drastic conditions prevail. In other words the repair parts have over a period of 20 years equalled 46c to each $100.00 worth of valves purchased. This is indicative of the amazing low cost of upkeep as compared with other types of valves requiring frequent renewal of seating parts, packings, stems and occasional re-welds. *Nordstrom repair parts over a period of years are about one-tenth cost as compared with other valves.*

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Reserves Lag Behind Rising Use of Petroleum

L. J. LOGAN
Economics Editor

INCREASED difficulty of matching U. S. oil needs with necessary oil finding was evident in the figures on U. S. reserves released March 8 by The American Petroleum Institute and American Gas Association. It is true that reserves of crude, natural gas liquids, and natural gas rose to new highs at the end of 1950, by virtue of proving up more reserves than were produced during 1950. But in view of unprecedented and still increasing oil use, having record reserves is not necessarily having adequate reserves, and finding more reserves than are being produced is not necessarily finding enough.

If reserves had consistently conformed with the pattern traditionally followed before World War II, total proved reserves of oil at the end of 1950 would have been about 3½ billion barrels greater than those just reported, and the industry would have proved up during 1950 almost 1 billion barrels more than it did.

Summary of Changes in 1950 in Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons

Source: Crude oil from American Petroleum Institute; natural gas liquids from API and American Gas Association

(THOUSANDS OF BARRELS)

CRUDE OIL		
Total proved reserves as of Dec. 31, 1949		24,649,480
Revisions of previous estimates	+463,378	
Extensions of old pools	1,354,301	
New reserves discovered in 1950 in new fields and in new pools in old fields	564,916	
Proved reserves added in 1950		2,883,085
Total proved reserves as of Dec. 31, 1949 plus new proved reserves added in 1950		27,212,174
*Less production during 1950		1,943,778
Total proved reserves as of Dec. 31, 1950		25,268,396
Increase in reserves during 1950		618,900
NATURAL GAS LIQUIDS		
Total proved reserves as of Dec. 31, 1949		3,729,012
Revision of previous estimates and extensions of old pools	+707,679	
New reserves discovered in 1950 in new fields and in new pools in old fields	56,183	
Proved reserves added in 1950		763,862
Total proved reserves as of Dec. 31, 1949 plus new proved reserves added in 1950		4,495,074
*Less production during 1950		227,411
Total proved reserves as of Dec. 31, 1950		4,267,663
Increase in reserves during 1950		538,651
TOTAL LIQUID HYDROCARBONS		
Total proved reserves as of Dec. 31, 1949		28,378,801
Revisions of previous estimates and extensions of old pools	+2,705,646	
New reserves discovered in 1950 in new fields and in new pools in old fields	622,099	
Proved reserves added in 1950		3,328,747
Total proved reserves as of Dec. 31, 1949 plus new proved reserves added in 1950		31,707,548
*Less production during 1950		2,171,187
Total proved reserves as of Dec. 31, 1950		29,536,061
Increase in reserves during 1950		1,157,260

*The 1950 production figures were compiled by API and AGA committees and where necessary are based on eleven months' actual production with an estimate for December. Any variance between the actual production, as later reported, and the figures used herein will be compensated for through revision when the following year's reserve report is compiled. These revisions have in the past been very small.

The API and AGA reports showed for the end of 1950 total reserves of liquid hydrocarbons amounting to 29,536,061,000 barrels, including 25,268,398,000 crude and 4,267,663,000 natural gas liquids. Conformity with prewar pattern would have put end-of-1950 reserves 3½ billion barrels higher or above 33 billion barrels. Similarly, instead of proving up 3,328,747,000 barrels of oil reserves during 1950, as reported, the industry would have proved up about 865 million barrels additional or a total of about 4.2 billion barrels.

These estimates of deficiencies in known reserves at the end of 1950 and in reserve proving during 1950 are based on industry experience in proving up and producing reserves throughout its history from the beginning up through 1941. At the end of that year, the industry had produced about 25.2 billion barrels of crude and held unproduced proved reserves of 19.6 billion barrels, having proved up meanwhile, therefore, a total of 44.8 billion barrels, equivalent to 177.8 percent of the amount produced or 1.77 barrels proved up for each barrel produced. This ratio is found to have been approximated for each of the five years, 1937-1941, reserves found having been in the ratio of 1.77 to 1.82 barrels for each barrel produced.

This particular ratio had been necessary to prevent deterioration of the industry's relative position on reserves and had been based roughly on maintaining reserves at 14 times annual production, with production itself constantly increasing about 5½ percent per year. For any individual year, it was necessary (1) to prove up new reserves in the amount of the year's production, protecting the reserve position in so far as former rate of production was concerned; and (2) in addition, to set up new reserves 14 times that part (5½ percent) of production representing increase over the previous year, since there was no reserve at all to support that newly established component of production, though there was need for such reserve in the order of 14 times annual production involved, as in the case of older reserves. Thus, new reserves needed to be proved up were found to be 100 percent of the year's production plus about 77 percent of the year's production, a total of 177 percent of the year's output, or 1.77 barrels proved for each barrel produced.

During and after World War II, there has been progressive divergence from that prewar pattern for reserves, with substantially less being proved up per barrel produced, and with this result accompanied by sharply increasing imports. Before the war, U. S. production not only equaled domestic requirements but also supplied some export demand, with exports exceeding imports. Since the war, the U. S. in 1947-1948 changed from net exporter to net importer, and in 1950 it was net importer of 198,114,000 barrels, besides producing from domestic reserves 2,171,187,000 barrels, according to API-AGA figures herewith. Adding these figures, the supply required totaled 2,369,301,000 barrels, and on prewar basis, all this would have

Summary of Changes in 1950 in Proved U. S. Reserves of Natural Gas

Source: American Gas Association

(MILLIONS OF CUBIC FEET)

Total proved reserves as of Dec. 31, 1949		180,361,344
Extensions and revisions of previous estimate	9,173,381	
New reserves discovered in 1950	2,877,381	
Net changes in "stored gas" during 1950	54,301	
Total proved reserves added and net changes in "stored gas" during 1950		12,104,063
Total proved reserves as of December 31 1949 and additions during 1950		192,465,377
Deduct production during 1950		6,892,678
Total proved reserves of natural gas as of December 31, 1950		186,572,699
Increase in natural gas reserves during 1950		5,211,355

come from U. S. reserves, which should have been 14 times this annual withdrawal, therefore totaling 33,170,214,000 barrels.

Similarly, if new reserves had been proved up during 1950 on the basis of 1.77 barrels for each barrel of the 2,369,301,000 barrels required for the year's use, the total proved up would have been 4,193,663,000 barrels. The 3,328,747,000 barrels actually reported to have been proved up represented only 1.40 barrels for each barrel required (production plus net imports) and were equivalent only to 1.53 barrels proved up for each barrel actually produced (disregarding net imports).

It is noteworthy, too, that the above figures include all liquid hydrocarbons, and that data on crude only would make a poorer showing than those totals, as the over-all results were improved somewhat by exceptionally large proving-up of reserves of natural gas liquids.

The fact that U. S. reserves are now several billion barrels "deficient" reflects under-finding for about a decade and helps to explain if not justify present relatively large imports. It is significant also that this deterioration of the U. S. position on reserves has occurred in spite of the setting of new records in recent years in footage drilled and in completions of total wells, oil wells, and wildcats.

The never-ceasing increase in oil use threatens to exceed conclusively the possibilities of oil finding in the U. S. and leave no alternative but to step up imports. Certain promising areas such as the tidelands may help to keep the country self-sufficient in oil for a while, but on the other hand, they may be needed merely to help maintain even the prevailing relatively high rates of oil finding, without making possible an improvement on these rates.

Estimated Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons, by Years
Sources: Crude oil by API, natural gas liquids by API and AGA
(THOUSANDS OF BARRELS)

	NEW OIL FOUND DURING YEAR					
	Through Revisions of Previous Estimates and Extensions to Known Fields	Through Discoveries of New Fields and of New Pools in Oil Fields	Total Through New Discoveries, Extensions, and Revisions (Column 1 + 2)	Production During Year	Estimated Proved Reserves as of End of Year (Column 3 − 4)	Increase Over Previous Year
	(1)	(2)	(3)	(4)	(5)	(6)
Crude Oil (Incl. Cycle Plant and Lease Condensate)						
1936					13,063,400	
1937	2,792,790	928,742	3,721,532	1,277,964	15,507,268	2,443,868
1938	2,243,571	810,493	3,054,064	1,213,196	17,348,146	1,840,878
1939	2,058,455	340,057	2,399,123	1,264,256	18,483,013	1,134,866
1940	1,607,012	286,338	1,893,350	1,351,847	19,024,515	541,502
1941	1,538,989	429,974	1,968,963	1,404,182	19,589,296	564,781
1942	1,618,925	260,051	1,878,976	1,385,479	20,082,793	493,497
1943	1,202,366	282,418	1,484,786	1,503,427	20,064,152	(—) 18,641
1944	1,556,192	511,308	2,067,500	1,678,421	20,453,231	389,079
1945	1,690,315	419,984	2,110,299	1,736,717	20,826,813	373,582
Crude Oil Only						
1945					19,941,846	
1946	2,413,628	344,434	2,658,062	1,726,348	20,873,560	931,714
1947	2,019,140	445,430	2,464,570	1,850,445	21,487,685	614,125
1948	3,398,726	396,481	3,795,207	2,002,448	23,280,444	1,792,759
1949	2,297,428	890,417	3,187,845	1,818,800	24,649,489	1,369,045
1950	1,997,769	584,916	2,582,685	1,943,776	25,288,398	618,909
Natural Gas Liquids (Condensate Natural Gasoline and Liquefied Petroleum Gases)						
1946					3,163,219	
1947	192,237	86,301	251,538	160,782	3,253,975	90,756
1948	405,874	64,683	470,557	183,749	3,540,783	286,808
1949	294,211	92,565	386,776	198,547	3,729,012	188,229
1950	707,879	58,183	766,063	227,411	4,367,663	638,651
Total Liquid Hydrocarbons (Crude Oil and Natural Gas Liquids)						
1946					24,036,779	
1947	2,211,377	804,731	2,716,108	2,011,227	24,741,660	704,881
1948	3,804,600	461,164	4,265,764	2,186,197	26,821,227	2,079,567
1949	2,591,639	982,982	3,574,621	2,017,347	28,378,501	1,557,274
1950	2,705,648	623,099	3,328,747	2,171,187	29,536,061	1,157,560

NOTE: Up to and including its figures on proved reserves of petroleum, as of December 31, 1945, the committee combined under that heading the estimated proved reserves of cycle-plant and lease condensate. As of December 31, 1945, the reserves so included totaled 884,967,000, bbl. and as of December 31, 1944 there were 668,701,000 bbl. included. Beginning with the report of December 31, 1946, the figures in this table show crude oil and natural gas liquids. It is to be remembered that, previous to December 31, 1946, not all classes of natural gas liquids were included. For this reason the totals for crude oil and natural gas liquids, as herewith recorded for 1946, 1947 and 1948, are not comparable with the figures recorded for years prior to 1946.

Estimated U. S. Reserves of Natural Gas, by Years
Source: American Gas Association
(Millions of Cubic Feet—14.65 psia, at 60° F.)

	ADDED DURING YEAR						
YEAR	Extensions and Revisions	Discoveries of New Fields and New Pools in Old Fields	Total of Discoveries, Revisions and Extensions	Net Change in Storage	Net Production During Year	Estimated Proved Reserves as of End of Year	Increase Over Previous Year
Natural Gas:							
1945						147,789,267	
1946	*	*	17,729,133	*	4,942,617	160,575,901	12,786,634
1947	7,570,554	3,410,170	10,980,824	*	5,629,811	165,926,914	5,351,013
1948	9,799,483	4,129,089	13,898,572	31,482	6,007,528	173,889,340	7,962,426
1949	8,061,429	4,612,870	12,674,299	82,746	6,245,041	180,381,344	6,512,004
1950	9,172,281	2,877,381	12,049,732	84,301	6,892,678	185,502,699	5,211,355

* Not estimated.

HF Acid Alkylation Unit Sets Production Record

Phillips Oil Company's Borger, Texas, refinery hydrofluoric acid alkylation unit set a new record production of 5570 barrels daily debutanized total alkylate in December, 1950. This unit is the first operating unit using hydrofluoric acid as an alkylation catalyst and has been in operation since December, 1942.

This record production was more than 300 percent of the production for which the plant was designed and required importing a high percentage of the feed stocks from sources outside the refinery.

This record production of alkylate required use of secondary feed stocks, such as propylene and catalytic polymer gasoline, and operating conditions, such as lower isobutane-olefin ratio, higher reactor temperatures, and lower purity of recycle isobutane, which caused a net lowering of the alkylate rating. This rating drop was off-set by use of special blending ingredients in the final fighter grade aviation blends.

Christian Named to Board

Erle G. Christian, Cities Service Company secretary, has been elected a member of the board of directors. He has been with Cities Service since 1914, and is a director of Cities Service Refining Corporation.

Refinery Wage Record High

An all-time-high record was reached in December when hourly wages of petroleum refinery employes reached $2.016. Refinery wages were greater than all other industry groups, except contract construction trades, according to Bureau of Labor Statistics' report on "Hours and Earnings." Weekly refinery wages averaged $82.05 for a 40.7 hour week to compare with bituminous mining average of $77.79 for a 38.7 hour week.

Again it's Elliott Turbines *for reliable pump drive!*

This time it's the Deep Rock Oil Corporation's plant at Cushing, Oklahoma, where up to thirty Elliott YR turbines, from 5 to 125 hp, drive various pumps in the refinery. A line of these units is shown in the photo above.

Low cost maintenance is well served by standardizing on these hardy turbines. With only five frame sizes for the entire capacity range, and with various governor and valve parts similar throughout, the inventory of replacement parts can be cut way down.

With the men whose job it is to keep things going Elliott turbines are pretty generally regarded as among the greatest worry-eliminators in the refinery. Bulletin H-16 tells why. Your request brings it.

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H-734

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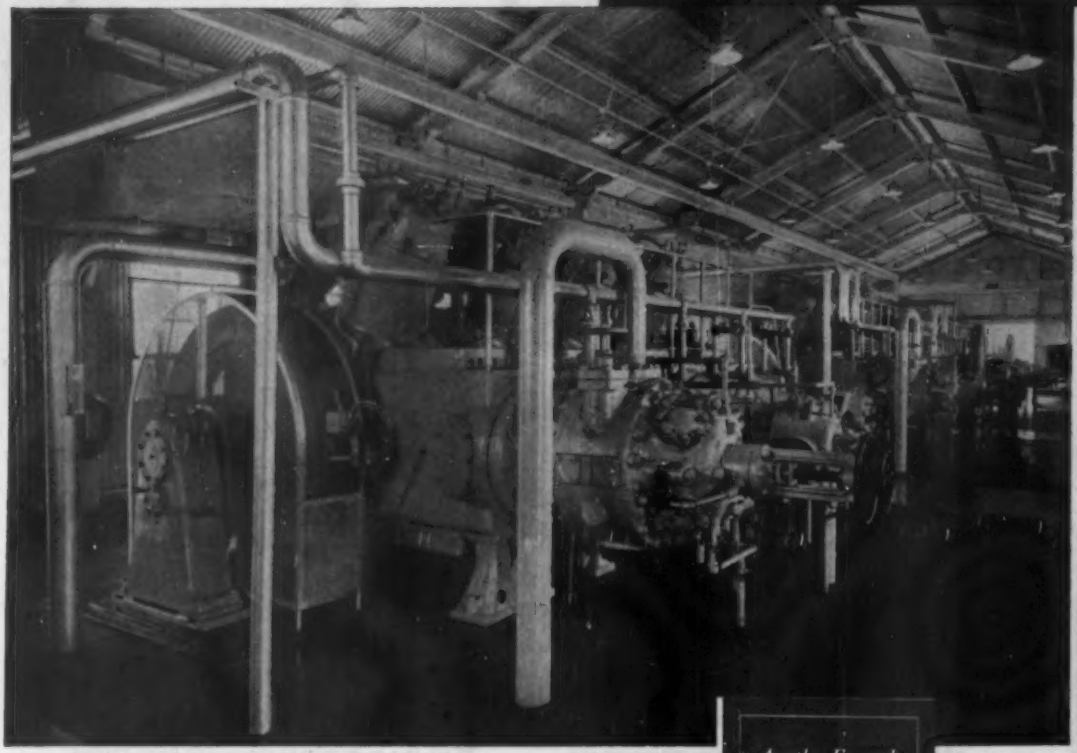
DISTRICT OFFICES IN PRINCIPAL CITIES

Magnolia makes the most of



Line-up of four Cooper-Bessemer 8-cylinder GMV compressors, rated 880 hp at 300 rpm, in Magnolia Petroleum Company's Chitwood Gasoline Plant. Here, multi-service operation involves 4800 psi discharge in cycling, 1,015 psi in gasoline extraction, 250 psi for vapor recovery. Flexibility is a keynote.

Another Example of Efficient Power at Lower Cost

ANGLE

Compressors

New York Washington, D. C. Bradford, Pa. Parkersburg, W. Va.
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.

gas conservation at Chitwood

WITH EFFICIENT, MULTI-SERVICE

GMV's

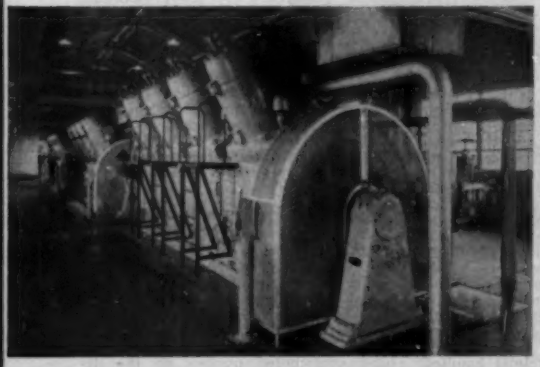
At the Chitwood plant, Magnolia Petroleum Company is doing an outstanding job of gas conservation . . . perhaps unique. The operation includes production of distillate by cycling . . . production of gasoline from casinghead gas . . . vapor recovery off of crude at atmospheric pressure . . . and a pressure maintenance operation.

The operation is of particular interest because it involves both high and low pressures, together with the vapor recovery service — all tied into the same compressor units.

As shown opposite and below, the compressors are efficient Cooper-Bessemer GMV Turboflows — chosen partly because they assure the true flexibility so essential in a multi-service operation such as this.

Whether your plans call for complex compressor service or the most simple kind of set-up, you'll be ahead with Cooper-Bessemer V-Angles. Then you'll be *sure* of economical installation, prolonged, low-cost performance, and the *flexibility* to meet fixed or variable requirements precisely. Better check with Cooper-Bessemer.

GMV's in Magnolia Chitwood plant, shown here from crankdoor side.



Exterior view of compressor building at Magnolia's Chitwood plant.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

BOOKS of Current Interest

Review and Comment for the Process Man

Pressure Piping

1951 Code for Pressure Piping, American Society of Mechanical Engineers, 29 West 39th Street, New York 18, $3.50.

Revision of the old 1942 Code and the addition of new material has brought the 1951 Code into line with current practice. Lists of material specifications contain new specifications and the latest effective dates of existing ones; tables of allowable stresses include values for new material, and ambiguous or conflicting requirements have been clarified. Pressure-temperature ratings of Supplement One of the Standard on Steel Pipe Flanges and Flanged Fittings have been adopted; included are provisions for pressure seal valve bonnets and welded bonnets and requirements for design pressure-temperature conditions for dead end instrument piping service. The current welding rules with examples and illustrations to show their application for reenforcement of welded branch connections and much more pertinent and new information is found in the new publication.

Measurement and Sampling

Measurement and Sampling of Petroleum and Petroleum Products, ASTM Manual, American Society for Testing Materials, 1916 Race Street, Philadelphia 3, $2 heavy paper cover, $2.65 cloth cover.

This manual, dated December, 1950, makes available recommended methods for measuring the volume of petroleum and for obtaining representative samples thereof. It represents the results of ten years of investigation and research by Division 11 on Measurement and Sampling, ASTM Committee D-2 on Petroleum Products and Lubricants. The material has been reviewed by the Institute of Petroleum (England).

Included contents are ASTM methods of gauging, temperature measurement, and sampling; recommended practice for volume calculations and corrections; and tests for water and sediment by centrifuge, and gravity by hydrometer, as well as a proposed method of sampling liquefied petroleum gases.

Engine Power Costs

Report on Oil and Gas Engine Power Costs for 1949, The American Society of Mechanical Engineers, 29 West 39 Street, New York 18, $2.50.

Three comprehensive tables of the 1949 report on oil and gas engine power costs contains performance and production data obtained from 102 oil generating plants, 16 plants with a total of 37 dual-fuel engines and four plants having ten dual-fuel engines. The tables contain information on: 1) items affecting production cost; 2) comparative costs for plants which have submitted statistics for two or more successive years; 3) engine details and operating information. Specific information covers type of load, number of engines, plant hours operated, gross and net output kw. hr., percentage of gross kw. hr. for plant purposes, cost of fuel and lubricating oils, attendance and superintendence, engine and other plant repairs, etc.

Petroleum Facts

Petroleum Facts and Figures, American Petroleum Institute, 50 West 50th Street, New York 20, $2.50.

Ninth edition of "Petroleum Facts and Figures" and first edition since 1947, one of the oil industry's most authoritative books on its vital statistics, is broader in scope than previous editions. Charts, graphs and other illustrations were held to a minimum to permit new tables and additional statistics. Long-term series of comparable tables on utilization, production, refining, marketing, transportation, prices and taxation are utilized wherever possible. These are complete historically and eliminate necessity to refer to earlier editions. The new tables on business, operating and allied statistics, coupled with historical information on the industry have made the 1950 issue much larger than previous issues.

Statistics for the many tables were collected and compiled by the research section of the Department of Information, with the assistance of other divisions of the Institute, government agencies, oil company authorities and independent oil experts. Present plan for the publication is to issue annual supplements to the new edition for five years, at which time a revised and complete edition will be published.

Testing Methods

Standard Methods for Testing Petroleum and Its Products, The Institute of Petroleum, 26 Portland Place, London, W.1, 31 Shillings.

The steady increase in the number of petroleum products and of their properties which are being brought under analytical control is reflected in the increased size of this edition. Standardized versions of an unusually large number of new and useful tests are given, and many older tests have been revised and improved. Outstanding example is the complete revision of the method for calorific value determinations which now includes full safety precautions and a specification for bomb calorimeters, in the preparation of which the Institute has had the advantage of much expert advice.

Technical detail is carefully handled, and the whole of the information given with any method is set down in the order which experience has shown to be the most readily useful to the user. In standardizing methods, the relative merits of many suggested variants are considered and the best of these selected; possible variants omitted from a standard method may usually be regarded as considered less advantageous by the IP (London) than the procedure proposed.

Gas Synthesis Process

Laboratory-Scale Work on Synthesis-Gas Production, Report of Investigations 4742, Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13. Free.

Development of one of the first laboratory processes for the continuous production of synthesis gas from pulverized coal is described. The process offers an easily controlled method for testing the gas-making qualities of various types of fuels.

A project of the Bureau's Synthesis Gas Production Laboratories at Morgantown, W. Va., in cooperation with West Virginia University, the laboratory scale pilot unit was constructed to feed pulverized coal by down-draft entrainment in oxygen and steam at a throughput rate up to 45 pounds of coal per hour. A synthesis gas of low carbon dioxide content, containing 90 percent monoxide and hydrogen was made from low-grade coals, and gas output rates as high as 600 cubic feet of carbon monoxide-hydrogen mixture per cubic foot of generator volume per hour were obtained. The process permits recycling the residue coal for further gasification.

Describing operation of the apparatus and modifications made during the development of the laboratory equipment, the Bureau report also offers theoretical data on the mechanism of powdered fuel gasification. The report contains tables of operating data and illustrations of equipment and flow diagrams.

Constants of Hydrocarbons

Physical Constants of Hydrocarbons Boiling Below 350° F., American Society for Testing Materials, 1916 Race Street, Philadelphia 3, $1.

This compilation of tables includes most of the physical constants of hydrocarbons (boiling below 350° F.) which would be valuable to testing engineers and others concerned with the natural gasoline, synthetic rubber, industrial aromatics, and gaseous fuels industries. The work was directed and much of it carried out by Robert Matteson, California Research Corporation, working with Technical Committee H on Light Hydrocarbons, of ASTM Committee D-2 on Petroleum Products and Lubricants.

Six classes of hydrocarbons are covered in the tables, including paraffins, mono-olefins, di-olefins, acetylenes and naphthenes, and aromatics.

ASTM plans to keep the tables up to date by issuing complete revisions approximately every five years.

Ion Exchange Phenomenon

Ion Exchange Resins, Robert Kunin and Robert J. Myers, John Wiley & Sons, 440 Fourth Avenue, N. Y. 16, $4.75.

The voluminous data existing on various phases of the ion exchange phenomenon are organized, digested and clarified by Drs. Kunin and Myers, Rohm & Haas Company research chemists, who have contributed notably to the development of Amberlite exchangers and associated ion exchange processes.

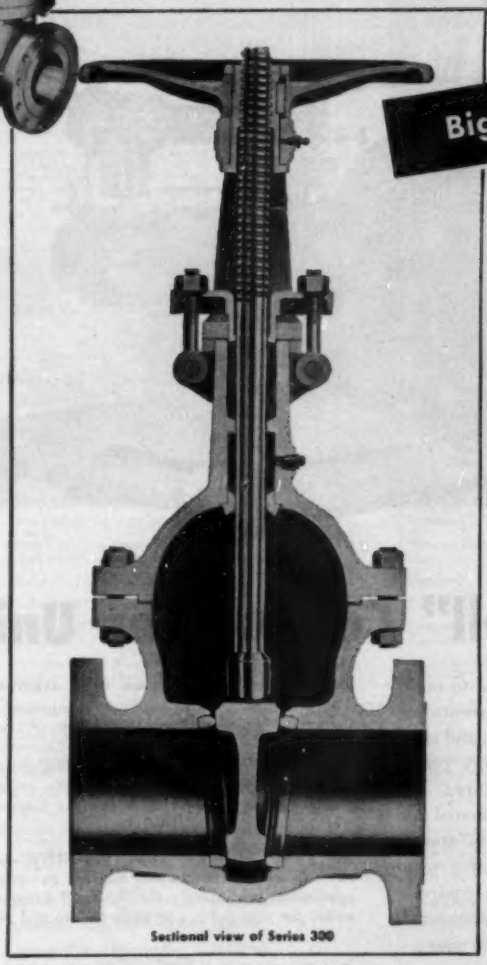
The result is a reference book plus a presentation of the theory underlying the ion exchange mechanism; the usefulness of the resins; operational and engineering data; and laboratory and industrial methods of using the resins throughout the power, chemical process, agricultural, medical, pharmaceutical, sanitation and other fields.

WALWORTH

Cast Steel Gate Valves

Series 150 and 300

Wedge Gate — Outside Screw and Yoke



Sectional view of Series 300

Big 8-Point Superiority!

Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2" to 24") insure tightness and maximum packing life — costly leaks are eliminated.

Bonnets and Bodies are engineered to withstand pressure and minimize distortion — they're tough, durable, dependable.

Heavy Steel Walls provide extra strength and longer life.

Integral Body Guide Rib Faces are machined to insure accurate disc seating.

Seat Rings are bottom seated — not flange type. No recess exists at back of ring — hence no turbulence, erosion, or pressure drop.

Streamlined Ports allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

Valves regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

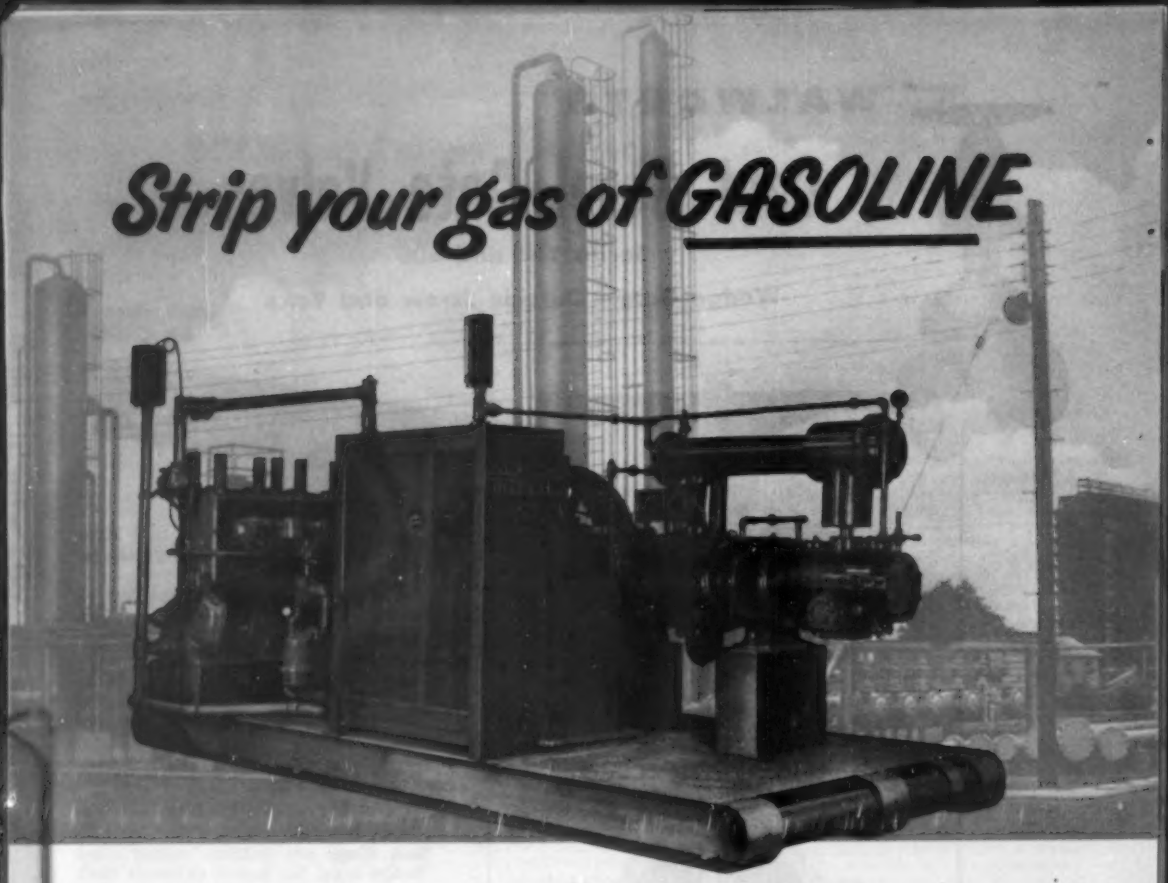
WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Strip your gas of GASOLINE



—with "Oilwell" Compressor Units

THESE Compressor Units are custom-made to meet your specific application requirements. Their heavy-duty construction, completeness-of-assemblies and conservative ratings result from "Oilwell's" many years' experience in engineering equipment of this type.

Single or multi-stage compressors are mounted on sturdy skid bases—suitable for inexpensive installations, with or without housing. Prime mover, together with adequate cooling systems, operating gauges, controls, etc. are all built-in and represent "balanced" components that will give dependable service with minimum maintenance.

Available in
25, 50, 75, 100, 125 and 150-HP Sizes

THE "OILWELL" COMPRESSOR UNIT ILLUSTRATED is in the 150-HP range . . . with two-stage compressor capable of taking gas at 25 psi and compressing it to 650 psi at the rate of approximately 731,000 cubic-feet-per-24-hours. It has a split-type cooler with separate, closed cooling system for the compressor, independent of the one for the engine. This unit is powered by a model NKU Waukesha Engine.

Let your "Oilwell" representative . . .
. . . help analyze the factors involved in your gasoline-plant application and specify the "Oilwell" Compressor Unit best suited for your job . . . or write for Booklet No. 17-51.

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UNITED STATES STEEL

REFINERY and Other PLANT CONSTRUCTION

Petroleum Refiner's *exclusive feature which, in boxscore form, presents a quick picture of the tremendous amount of plant construction work that is in progress or projected by oil and other companies in all sections of the world.*

(Construction notes this month appear on page 169.)

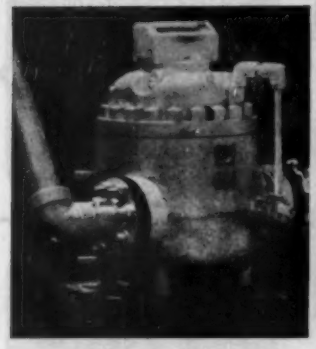
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
*Ashland Oil & Refining	Buffalo, N.Y.	Crude Unit Exp.	15,000 bbls.	.....	Under Constr.	.....	.....	.....	Cat. Constr.
Atlantic Refining Co.	Philadelphia, Pa.	Detergent Mfg. Facilities	.....	$1.5 million	Under Constr.	.....	.....	.....	.....
*Atlantic Refining Co.	Point Breeze, Philadelphia	Catalytic Reforming Unit	11,000 bbls.	$4 million	Under Constr.	1952	.....	.....	.....
Aurora Gasoline Co.	Detroit, Mich.	Platforming Unit	4,500 bbls.	.....	Under Constr.	May, 1951	U.O.P.	U.O.P.	U.O.P.
California Refg. Co.	Perth Amboy, N. J.	Crd. Running. Cat. Crk.	80,000 bbls.	$30 million	Completed	.....	Houdry, U.O.P.	Braun, Kellogg, McKee, Staff	Braun, Cat. Constr., Utility Constr. Co., Edw. R. Ellis & Sons.
Calif. Refg. Co.	Barber, N.J.	Crd. Cat. Crk., Reformer, Alkylation Crude Units Boiler Plants	25,000 bbls. 10,000 bbls. 5,000 bbls. 50,000 bbls. 300,000 lbs./hr.	....	Completed Completed Completed Completed Completed	....	Houdry U.O.P. Kellogg	Houdry, Braun Braun Kellogg Braun Braun	Braun Braun Kellogg Braun Braun
Calif. Refg. Co.	Barber, N.J.	3 Gaso. Trtng., Lead Sulfide Sweetening Plt., Reagent Plt.	.....	.....	Completed	.....	.....	Cat. Constr.	Cat. Constr.
*Cambridge Gas Light Co.	Cambridge, Mass.	Light Oil Recov.	24 Mmcf	.....	Contracted	1951	.....	Blaw-Knox	Blaw-Knox
Esso Standard Oil Co.	Bayway, N.J.	2 Desulf. Units	45,000 each	.....	Under Constr.	July, 1951	.....	.....	.....
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery	40 tons	.....	Completed	.....	.....	.....	Girdler
Kendall Refg. Co.	Bradford, Pa.	Platforming Unit	1,500 bbls.	.....	Under Constr.	Spring, 1951	.....	U.O.P.	U.O.P.
*Koppers Co., Inc. (Chem. Div.)	Kobuta, Pa.	Additions	.....	.....	Planned	.....	.....	.....	.....
Louisville Refining Co.	Louisville, Ky.	Cat. Cracker	3,000 bbls.	$2 million	Under Constr.	July, 1951	.....	U.O.P.	.....
Mathieson Hydrocarbon Chemical Corp.	Brandenburg, Ky.	Chemical Plt.	.....	$17 million	Under Constr.	End 1951	.....	Badger, Stone & Webster	Badger, Stone & Webster
Mid-West Refineries, Inc.	Alma, Mich.	Platforming Unit	1,500 bbls.	.....	Under Constr.	May, 1951	U.O.P.	U.O.P.	U.O.P.
*New Bedford Gas & Edison Light Co.	New Bedford, Mass	Light Oil Recov.	24 Mmcf.	.....	Contracted	1951	.....	Blaw-Knox	Blaw-Knox
New York State Natural Gas Corp	Boom Sta., Lawrenceville, Pa.	Nat'l.-Gas Dehydration Plt.	200,000 mcf	$350,000	Under Constr.	Spring, 1951	.....	Blaw-Knox	Staff
Socony-Vacuum Oil Co.	Buffalo, N.Y.	Poly Plt.	.....	.....	Completed	.....	.....	Bechtel-Staff	Bechtel
Socony-Vacuum	Buffalo, N.Y.	Expand. Gas Recov. Facilities	.....	.....	Completed	.....	.....	Bechtel-Staff	Bechtel
Socony-Vacuum	Buffalo, N.Y.	Houdry to TCC	15,000 bbls.	.....	Completed	.....	Socony-Vacuum	Bechtel-Socony	Bechtel
Socony-Vacuum	Buffalo, N.Y.	Miscl. Refg. Alterations	.....	.....	Completed	.....	.....	Bechtel-Socony	Bechtel
Socony-Vacuum	Brooklyn, N.Y.	Houdry to TCC	15,000 bbls.	.....	Under Constr.	Early 1951	Socony-Vacuum	Foster Wheeler	Foster Wheeler
Socony-Vacuum	South Norfolk, Conn.	Liquefied Pet. Gas Fill. & Distr. Plt.	.....	.....	Completed	.....	.....	.....	.....
L. Sonneborn Sons	Petrolia, Pa.	Anticollution Acid	.....	$430,000	Under Constr.	1st Half, 1951	.....	Chemico, Knowles	Knox & Wine, Chemico
Tennessee Gas Transmission Co.	Greensburg, Ky.	Stripping Plt.	780,000 mcf gas	$12 million	Under Constr.	Spring, 1951	.....	Stone & Webster	Stone & Webster
Union Oil Co.	Edmonds, Va.	Asphalt Refinery	65,000 tons	.....	Under Constr.	June, 1951	.....	.....	Bechtel
United Refining Co.	Warren, Pa.	Lab.	.....	.....	.....	Spring, 1951	.....	.....	.....
MID-CONTINENT									
*Ashland O & Ref.	Canton, Ohio	Fluid Cat. Crk.	8,000 bbls.	$4 million	Under Constr.	.....	U.O.P.	.....	McKee
c/"Same"	"Same"	Gas Conc. Unit	.....	.....	Under Constr.	.....	U.O.P.	.....	McKee
c/"Same"	"Same"	Cat.poly Unit	1,800 bbls.	.....	Under Constr.	.....	U.O.P.	.....	McKee
c/"Same"	"Same"	Add. Crude & Treating tankage	20,000 bbls.	.....	Under Constr. Under Constr.	....	....	....	McKee McKee
*Ashland Oil & Refining	Findlay, Ohio	Crude Unit Expansion	12,000 bbls.	.....	Under Constr	.....	.....	.....	Cat. Constr.
The Bell Oil and Gas Co.	Grandfield, Okla.	Platforming Unit	1,500 bbls.	.....	Completed	.....	.....	U.O.P.	.....
Ben Franklin Refining Co.	Ardmore, Okla.	Skimmer Furnace, Crk. Furnace	10,000 bbls.	.....	Completed	.....	.....	.....	.....
*Cities Service Oil Co.	Chicago, Ill.	Grease-Making Fac.	8.5 million lbs.	.....	Planned	End 1951	.....	.....	.....
Cities Service Oil Co. (Del.)	Ponca City, Okla	Cat. Crk. & Cat. Poly, Gas Plt.	8,000 bbls.	.....	Engineering	Late, 1951	.....	Kellogg	Kellogg
*Columbian Carbon Co.	El Dorado, Ark.	Carbon Black Plt.	66,000 lbs.	$1.5 million	Under Constr.	.....	.....	.....	.....
Consolidated Gas Utilities Corp.	Cement, Okla.	Compr. Sta.	40,000 mcf	.....	Completed	.....	.....	Dresser	Dresser U.O.P., Bowen & Lile
Continental Oil Co.	Ponca City, Okla.	Res. Lab. Bldg.	.....	$2.3 million	Under Constr.	Fall 1951	.....	Wigton-Abbott	Wigton-Abbott
The Derby Oil Co.	Wichita, Kans.	T.C.C. Cat. Poly Gas Consent.	.....	$2 million	Under Constr.	4th Qtr., 1951	Socony-U.O.P.	/	.....
Dowse Oil Co.	Warren, Ohio	Lube Filtering	250 bbls.	$15,000	Under Constr.	Spring, 1951	.....	Staff	Staff
Dow Chemical	Midland, Mich.	2nd Hyperscrption Unit	.....	.....	Contracted	.....	Union Oil (Calif.)	Foster Wheeler	Foster Wheeler

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Hugoton Plains Gas & Oil Co.	Hooker, Okla.	Nat. Gasoline Stripping Plt.	2,380 bbls. Nat. Gas Prod.	.....	Under Constr.	Mar. 1, 1951	.....	.....	.....
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cr.	4,000 bbls.	.....	Under Constr.	1951	.....	U.O.P.	Staff
Indiana Farm Bureau	Mt. Vernon, Ind.	Gas Conson.	3,500 bbls.	.....	Under Constr.	1951	.....	.....	U.O.P.
Indiana Farm Bureau	Mt. Vernon, Ind.	Vacuum Unit	300 bbls.	.....	Under Constr.	1951	.....	.....	U.O.P.
Johnson Oil Refg. Co.	Cleveland, Okla.	Platforming	1,800 bbls.	$750,000	Under Constr.	May, 1951	.....	U.O.P.	Procon, Inc.
Kerr-McGee Oil Ind.	Wynnewood, Okla.	Remodeling; Conversion & Additions to Present Fractionating Columns	10,000 bbls.	$600,000	Completed	.....	.....	.....	.....
Lake Superior Refining Co.	Superior, Wisc.	Revamping, Enlarging	5,000 bbls.	.....	Completed	.....	U.O.P.	Ref. Eng.	Ref. Eng.
Lake Superior Refining Co.	Superior, Wisc.	Cat. Crk.	4,000 bbls.	.....	Under Constr	May, 1951	U.O.P.	.....	.....
Midland Co-Op. Wholesale Co.	McPherson, Kans.	Expansion	†22,000 bbls.	$4 million	Planned	.....	.....	.....	.....
Mississippi River Fuel Co.	Fredericktown, Mo.	Comp. Sta.	4,000 hp.	.....	Under Constr.	Spring, 1951	.....	Ref. Maint.	Ref. Maint.
National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization, Fld Cat. Crk., Add tnkge, Util.	†22,000 bbls.	$2 million	Under Constr.	.....	U.O.P.	Ref. Eng.	Ref. Eng.
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	300 bbls.	$40,000	.....	.....	.....	.....	.....
Pan-Am. Southern Corp.	El Dorado, Ark.	Fluid Cat. Crk., Vap. rec. Unit	7,000 bbls.	.....	Completed	.....	.....	Foster Wheeler	Foster Wheeler
Peteo Corp.	Blue Island, Ill.	Houdry, Cat. Crk., LGP Recov.	5,000 bbls.	$400,000	Completed	.....	.....	.....	.....
Petroleum Specialties, Inc.	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$3 million	Planning	.....	.....	.....	.....
*Phillips Petroleum Co.	Okmulgee, Okla.	Cat. Crk. with Feed Prep. Unit & Gas Plt.	.....	.....	Planning	May, 1952	.....	.....	.....
The Shallow Water Refining Co.	Shallow Water, Kans.	Poly Unit	60 bbls.	$100,000	Under Constr.	Mar. 1, 1951	U.O.P.	Koch	Staff
Shell Oil Co.	Elk City, field Okla.	Gas Extrct Plt.	100,000 mcf gas	.....	Contracted	Jan., 1951	.....	Ref. Maint.	Ref. Maint.
Shell Oil Co.	Wood River, Ill.	Platforming Unit	15,000 bbls.	.....	Under Constr.	Oct., 1951	U.O.P.	U.O.P.	Procon
Standard Oil Co., (Indiana)	Neodesha, Kans.	Cat. Crk. Expn.	.....	.....	Planning	.....	.....	.....	.....
Socony-Vacuum Oil Co., Inc.	E. Chicago, Ind.	Houdry to TCC	15,000 bbls.	.....	Under Constr.	Early 1951	.....	.....	Braun
Socony-Vacuum	E. Chicago, Ind.	Houdry Conv. to T.C.C.	.....	.....	Planning	.....	Socony-Vacuum	.....	.....
Socony-Vacuum	Augusta, Kans.	Houdry TCC	15,000 bbls.	.....	Under Constr.	Jan., 1951	Socony-Vacuum	Fluor	Fluor
Socony-Vacuum	East St. Louis, Ill.	Thermal Crk., Reforming, Visbrk.	15,000 bbls.	.....	Completed	.....	.....	Bechtel-Socony	Bechtel
Socony-Vacuum	Trenton, Mich.	Houdry to TCC	15,000 bbls.	.....	Completed	.....	Socony-Vacuum	.....	Braun
Standard Oil Co. (Ohio)	Cleveland, Ohio	Cat. Cracker	29,000 bbls.	.....	Completed	.....	.....	Bechtel	Bechtel
*Standard Oil Co. (Ohio)	Lima, Ohio	Terminal Fac.	.....	$2 million	Planning	.....	.....	.....	.....
**"Same"	Toledo, Ohio	Terminal Fac.	.....	.....	.....	.....	.....	.....	.....
**"Same"	Columbus, Ohio	Terminal Fac.	.....	.....	.....	.....	.....	.....	.....
Standard Oil Co., (Indiana)	Neodesha, Kans.	Revamping Crd. Dist., Coking & Re-running Units; New Tankage and Utilities	†9,300 bbls.	.....	Under Constr.	1st Qtr., 1952	.....	.....	.....
Standard (Ohio)	Cleveland, Ohio	Crd. Dist. Plt.	45,000 bbls.	$2½ million	Planning	Jan., 1952	.....	.....	McKee
Standard (Ohio)	Cleveland, Ohio	Houdry to TCC	18,000 bbls.	$4 million	Completed	.....	Socony-Vacuum	Bechtel	Bechtel
Stanotind Oil & Gas Co.	7 mi. W. Ulysses, Kans.	Inc. Cap. to Gaso Plt.	200,000 mcf	.....	Planning	Early 1952	.....	.....	.....
The Texas Co.	Lawrenceville, Ill.	Expand Refinery	†20,000 bbls.	.....	Under Constr.	April, 1951	.....	Foster Wheeler Kellogg	Foster Wheeler, Kellogg
SOUTHWEST									
Alba Refg. Co.	Alba, Texas	Asphalt Refining	2,000 bbls.	$150,000	Completed	.....	.....	.....	.....
Atlantic Refining Co.	Port Arthur, Texas	Detergent Mfg. Facilities	.....	$1.5 million	Under Constr.	.....	.....	.....	.....
Arizona Interests	Florence, Ariz.	Refinery	15,000 bbls.	$25 million	Planning	1952	.....	Ebasco	
Arkansas-Louisiana Gas Co.	Blanchard, La.	4,200 hp Compressor Sta.	65,400 mcf	.....	Under Constr.	Spring, 1951	.....	Staff	Delta
Barnsdall Oil Co., Op. Bay Petroleum Corp.	Scurry Co., Tex. Chalmette, La.	Nat. Gaso. Plt. Modernization Fluid Cat. Crk., Revamping UOP Thermal Cracking for Feed Preparation	50,000 mcf gas 6,000 bbls.	$6.5 million	Considering Under Constr.	Feb., 1951 End 1951	..... U.O.P.	..... U.O.P.	..... Procon, Inc.
Cabot Carbon Co. (Godfrey L. Cabot, Inc.)	Big Springs, Texas	Carbon Black Plt.	126,986 lbs.	.....	Under Constr.	May, 1951	.....	Cabot Eng.	.....
Cabot Carbon Co. (Godfrey L. Cabot, Inc.)	Bayou Sale, St. Mary Parish, La.	Thermal Black Plt.	126,986 lbs.	$4 million	Designing	1952	.....	.....	.....
Cabot Carbon Co. (Godfrey L. Cabot, Inc.)	Bayou Sale, St. Mary Parish, La.	Oil Furn. Carbon Blk. Plt.	82,192 lbs.	.....	Designing	1953	.....	.....	.....
Continental Oil Corp.	Lake Charles, La.	Expansion, Cat. Crk., add equip. for High Octane Production	25,000 bbls.	$10½ million	Planning	Early 1952	.....	Badger	Badger
Commercial Petroleum & Transport Co.	Cold Spring Field, San Jacinto, Texas	Compressor, Dehydration, Metering	15 M mcf	$235,000	Under Constr.	Mar., 1951	.....	Chas. F Sanderson	Pioneer
Continental Oil Black Co.	Lake Charles, La.	Carbon Black Plt.	.....	$1.5 million	Under Constr.	.....	.....	.....	.....
*Camden Petroleum Corp.	Big Spring, Texas	Platforming Unit, and Recovery Facilities	3,500 bbls.	.....	Planned	Summer 1952	.....	Univ. Oil	Procon.
**"Same"	"Same"	Crude Still	4,000 bbls.	.....	Under Constr.	July 1, 1951	.....	.....	.....
Del Rey Petroleum Co.	Chesterville, Texas	Pressure Absorption Plt.	35,000 mcf	.....	Under Constr.	.....	.....	O. L. Olsen	Olsen

* Continued on page 143

EQUIPMENT WITH ENGINEERING SERVICE



Smith 2" Model M-12 1000-lb. WP Meter measuring distillate from oil and gas separator.

FIELD INSTALLATION FOR THE CONSERVATION OF NATURAL GAS...

This Texas Gulf Coast installation designed by Maintenance handles ten wells. Oil and gas flow from the lease into the ten selective manifolds, thence to separators suitable to working or flowing pressure. The gas separated in these units goes into a gathering system, is compressed and reinjected into the formation, eliminating flares and gas waste.

In this installation, the 125-lb. W.P. separator is so arranged with gas meter runs and oil meters that, with selective valving on the selective manifold, any well on the lease can be tested. Each separator is equipped with a Smith positive displacement oil meter that registers the total production of wells flowing into this separator, thereby relieving the producer from actual tank gauging, except for periodic checks.

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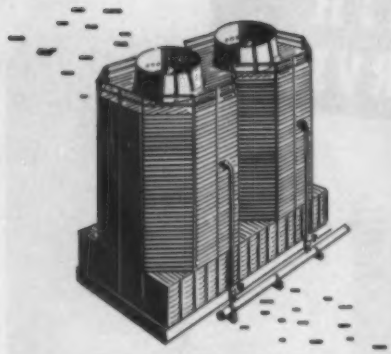

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When selecting cooling towers, it pays to look into the structural and mechanical design features of a Fluor Counterflo Cooling Tower. It is here that the difference between one cooling tower and another is evident—where the difference in structural stability, maintenance of mechanical equipment, and quality appearance lies.

The illustration at right—accurate in every detail—is the way your Fluor Counterflo Cooling Tower will look with a portion of the exterior wall removed. Note the exclusives, the extras, that make Fluor Cooling Towers a wise buy. When *dependable* performance, *low* maintenance, and *quality* appearance is essential or desirable in your plant or process operations, look into a Fluor Counterflo Cooling Tower.

Fluor Counterflo Induced-Draft Cooling Towers incorporate many important design features which cut the cost of maintenance and improve the appearance of cooling equipment installations.

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DOUBLE-WALL SHEATHING

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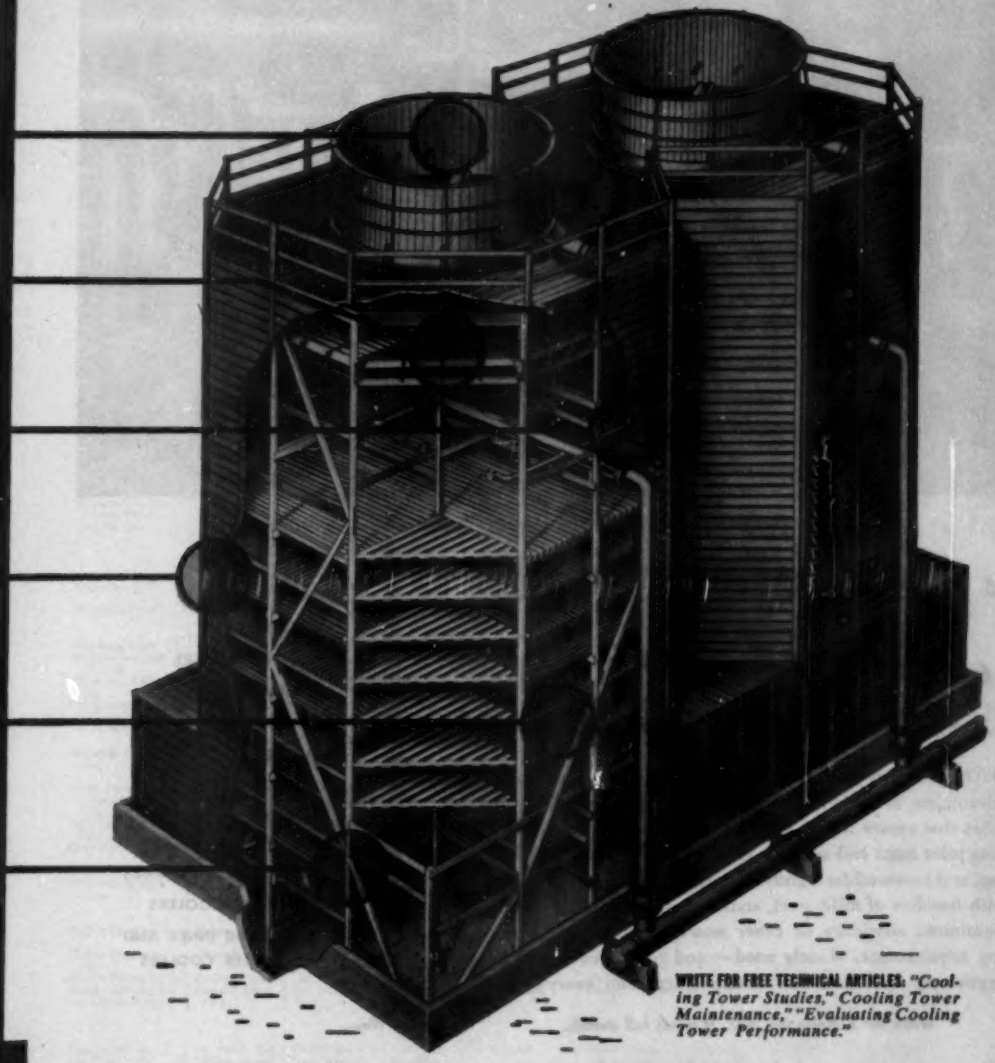

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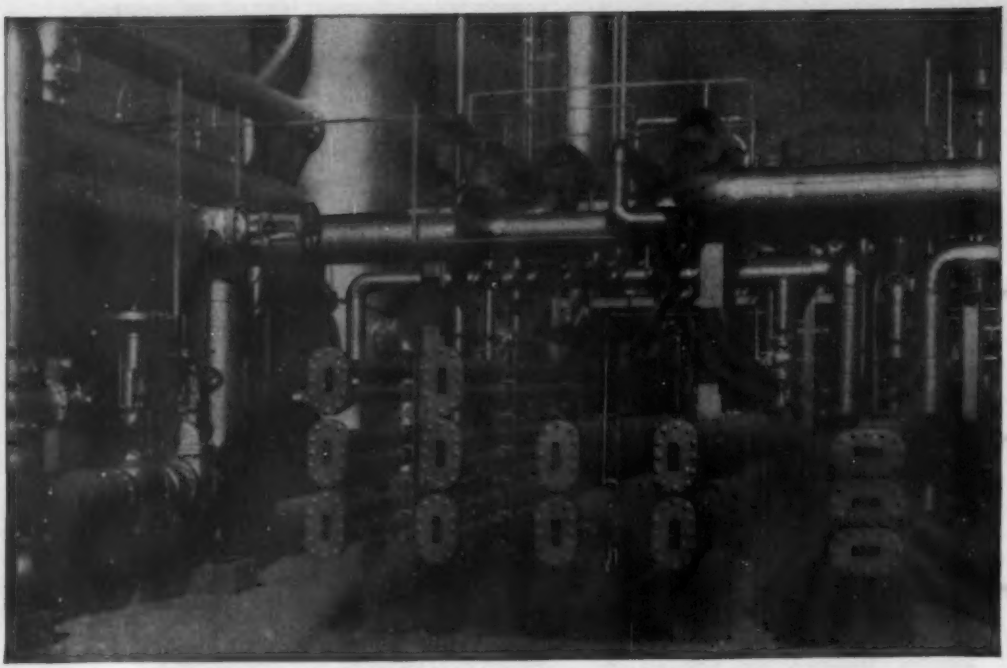

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Sectional Hairpin

HEAT EXCHANGERS *as*

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THE BROWN FINTUBE CO.
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SECTIONAL HAIRPIN HEAT EXCHANGERS

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Dodds Refining Co.	Jacksonville, Texas	Refinery Repairs	.....	.....	.....	.....	.....	.....	.....
The Dow Chemical Co.	Freeport, Texas	Chemicals, Expansion	.....	$30 million	Engineering	End 1951	.....	Staff	Tellepsen, Pritchard, Austin, Stone & Webster
Dow Chemical	Freeport, Texas	Ammonia Plt.	100 tons	$5 million	Completed	.....	.....	.....	Austin
El Paso Natural Gas	Scurry County, Texas	Compressor Sta.	2,640 H.P.	$800,000	Completed	.....	.....	Staff	Staff
E. I. DuPont de Nemours & Co., Inc.	Victoria, Texas	Chemical Intermediate for Nylon	.....	.....	Completed	.....	.....	Staff	Staff
*E. I. Du Pont de Nemours & Co., Inc	Orange, Texas	Expand Polythene Manuf. Facilities	60 Mmcf.	.....	Planning	Late 1952	.....	.....	.....
*El Paso Natural Gas	McElroy-Crane Field, W. Texas	Treating Plt.	16.76 Mmcf.	.....	Completed	.....	.....	.....	.....
Esso Standard	Baton Rouge, La.	Desalting Unit	55,000 bbls.	.....	Under Constr.	April, 1951	.....	.....	.....
Ethyl Corporation	Baton Rouge, La.	Pilot Plt. Bldg.	.....	.....	Completed	.....	.....	Staff	Pioneer
Ethyl Corp.	Houston, Texas	Chemicals Mfg. Plt.	100 mln. lbs./yr.	.....	Under Constr.	End 1951	.....	Braun, Badger	.....
Fullerton Oil Co.	Snyder, Texas	Refrig. Nat. Gaso. Plt.	40,000 mcf	.....	Under Constr.	Spring, 1951	.....	.....	Hudson
*Gladwater Refining Co.	Gladewater, Tex.	Perco Cycloversion Unit	600 bbls.	.....	Completed	.....	.....	Grebe & Doremus	Grebe & Doremus
Gulf Oil Corp.	Port Arthur, Texas	Fluid Cat. Crk.	60,000 bbls.	$3 million	Under Constr.	Sept., 1951	.....	Kellogg	Kellogg
*Gulf Oil Corp.	Pt. Arthur, Tex.	Ethylene Plt.	6.85 Mmcf.	.....	Contracted	Spring, 1951	.....	.....	Lummus
*Gulf Oil Corp.	Pt. Arthur, Tex.	Iso-Octyl Alcohol Fac.	24,657 lbs.	.....	Planning	End, 1952	.....	.....	.....
J. M. Huber Corp.	Baytown, Texas	Car. Blk. Plt. (3)	197,000 lbs.	$1.5 million	Under Constr.	May-Nov., 1951	.....	.....	Stearns-Rogers
Humble Oil & Ref. Co.	Baytown, Texas	Cat. Crk. Revamp	.....	.....	Completed	.....	.....	Staff	Pioneer
Humble O&R.	Baytown, Texas	Miscl. Facilities	.....	$1 million	Projected	.....	.....	.....	.....
Humble O&R.	Baytown, Texas	3 stage Crude	48,000 bbls.	.....	.....	Mid., 1951	.....	Foster Wheeler	Foster Wheeler
Humble O&R.	Jourdanton, Texas	Nat. Gasoline Plt.	26 M mo.	.....	Completed	.....	.....	.....	.....
*Hunt Oil Co.	E. Haynesville, La.	300 Comp. Sta.	.....	.....	Completed	.....	.....	Delta	Delta
*Inland Refining Co.	Palestine, Texas	Cat. Poly., Cycloversion Unit	.....	.....	Designing	.....	.....	Grebe & Doremus	Grebe & Doremus
*"Same"	"Same"		400 bbls.	.....	Designing	.....	.....	Grebe & Doremus	Grebe & Doremus
Jefferson Chemical Co.	Port Neches, Texas	Ethanolamine Plt.	.....	.....	Under Constr.	4th Qtr., 1951	.....	Braun	Braun
*Koppers Co., Inc. (Chem. Div.)	Pt. Arthur, Tex.	Chem. Plt.	.....	.....	Const. June	.....	.....	Koppers	Koppers
*Lion Oil Co.	Diamond M & Sharon Ridge Fields, Scurry County, Texas	Casinghead and LPG Plt.	80,000 Mcf.	$6,500,000	Under Constr.	Aug. 1, 1951	.....	Hudson Eng.	Hudson and Others
Magnolia Pet.	Beaumont, Tex.	Houdry to TCC	15,000 bbls.	.....	Under Constr.	May, 1951	.....	.....	.....
Magnolia Pet Co.	Beaumont, Tex.	Two Houdry's to TCC	30,000 bbls.	.....	Completed	.....	.....	.....	Lummus
*Magnolia Pet. Co.	Hurricane Creek Field, Beauregard Parish, La.	Casinghead Gasoline Plt.	.....	.....	Designed	.....	.....	.....	.....
Mathieson Chem. Co.	Pasadena, Texas	Fertilizer Plt.	.....	.....	Completed	.....	.....	Owner	.....
McBride Refining Co., Inc.	La Blanca, Tex.	Perco Cycloversion Unit	1,000 bbls.	.....	Completed	.....	Phillips	Grebe & Doremus	.....
McMurrey Refining Co.	Tyler, Texas	Fluid Cat. Cracker.	5,000 bbls.	.....	Under Constr.	May, 1951	.....	U.O.P. and Ref. Eng.	Ref. Eng.
*McMurrey Refining	Tyler, Texas	Poly Unit	350 bbls.	.....	Under Constr.	Jan., 1951	.....	.....	Ref. Eng.
*"Same"	"Same"	Vac.-Flasher	4,000 bbls.	.....	Under Constr.	Jan., 1951	.....	.....	Ref. Eng.
*"Same"	"Same"	Gas Recov. Thermal Crk.	.....	.....	Under Constr.	Jan., 1951	.....	.....	Ref. Eng.
Monsanto Chemical Co.	Texas City, Tex.	Acrylonitrile Mfg. Facil.; Plt. Expansion	.....	$30 million	Planning	.....	.....	.....	.....
North American Oil Consolidated & Ungren & Frazier	Bartlett Field, Jones County, Texas	Gaso. Plt., Gas Injection Facilities	.....	.....	Planning	.....	.....	.....	.....
Oil & Chemical Prod., Inc.	Houston, Texas	Distillation & Treating Unit	2,000 bbls.	.....	Completed	.....	.....	.....	Delta Engrg. Co.
Onyx Refining Co.	Abilene, Texas	Platforming Unit, Thermal Crk. Still	550 bbls.	$650,000	Under Constr.	June,1, 1951	U.O.P.	.....	Staff
*Pan Am Southern Corp.	Destrehan, La.	Cat. Crk. Unit Gas Plt., Alkylation, Hydroformer	20,000 bbls.	$6.5 million	Planning	May, 1952	.....	.....	.....
Phillips Chemical Co.	Borger, Texas	Carbon Black Plt.	80,000 tons/yr.	.....	Planning	4th Qtr., 1951	.....	.....	.....
Phillips Petroleum Co.	Alvin, Texas	Cycling Plt.	.....	$5 million	Planning	.....	.....	.....	Brown & Root
Phillips Petroleum Co.	Phillips, Texas	Cat. Cracker	20,000 bbls.	.....	Under Constr.	July, 1951	.....	.....	Braun
Pontiac Refining Co. & Chicago Corp.	Corpus Christi, Texas	Ref. Petro-chem. Plt.	5,000 bbls. gaso., 170,000 bbls. ethylene glycol, 3,000 lbs. ethylene	$15 million	Design, Planning	Mid., 1951	.....	.....	.....
Premier Pet. Co.	Ft. Worth, Tex.	Platforming Unit	1,500 bbls.	$750,000	Under Constr.	April, 1951	U.O.P.	U.O.P.	.....
The Pure Oil Co.	Dollarhide, Andrews Co., Tex.	Nat. Gaso. Plt.	$6 million	.....	Under Constr.	Spring, 1951	.....	.....	Hudson
*Pure Oil Co.	Nederland, Tex.	API Oil Sep.	.....	.....	Under Constr.	Fall, 1951	.....	.....	Trotti and Thompson
Rohm & Haas	Deer Park, Tex.	Acd. Steam Cap.	.....	.....	Completed	.....	.....	.....	.....
R. Lacy, Inc.	Big Sandy, Tex.	Gas Stabilizer, Poly, Perco Cycloversion Unit	1,300 bbls.	.....	Completed	.....	Phillips	Parsons	Turner
Shamrock Oil & Gas Corp.	McKee, Texas	Reconstruct Gaso. Ref. Treater	.....	$80,000	Planning	.....	.....	.....	.....
Shamrock Oil & Gas Co.	Sunray, Texas	Houdry Cat. Crk.	10,000 bbls.	.....	Completed	.....	Houdry	.....	Cat. Constr. (Philadelphia)
Shell Chemical Co.	Houston, Texas at Deer Park	Ethyl Alcohol Denaturing Plt.	.....	.....	Completed	.....	.....	Staff	Pioneer

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

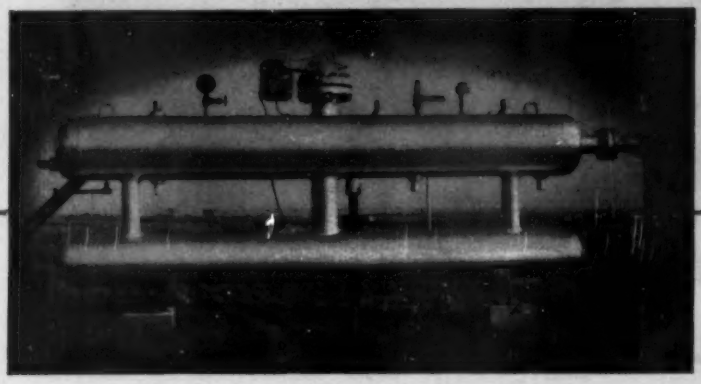
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Chemical Co.	Houston, Texas	Expand Ethylene & Ethyl Chloride Prod.; Glycerine Plt. Extension	.....	.....	Under Constr.	4th Qtr., 1951	.....	Fluor	Fluor
Shell Oil Co.	Houston, Texas	Platforming Unit	15,000 bbl.	.....	Under Constr.	Oct., 1951	U.O.P	U.O.P.	Procon
*Shell Oil Co.	Mogadore, Ohio	Marketing Terminal	.....	$160,000	Under Constr.	2nd Qtr., 1951	.....	.....	Poling & Bacon
Sid Richardson Refining Co.	Texas City, Tex.	Refinery Alterations	30,000 bbls.	.....	Under Constr.	Spring, 1951	.....	Staff	Staff
Stanolind Oil	Brownsville, Tex.	Chemical Plt.	100 tons	.....	Completed	.....	.....	Badger	Badger
Stanolind Oil & Gas Co.	Tulsa, Okla.	Research Center	.....	.....	Planning	.....	.....	Shreve, Lamb and Harmon Assoc.	.....
Sunray Oil Corp. (Op.)	Snyder, Scurry Co., Texas	Gasoline Plt.	14,000 bbls.	$7.5 million	Contracted	July, 1951	.....	Fluor	Fluor
Superior Oil Co.	Ramsey Field, Colo. Co., Tex.	Nat. Gasn. Plt.	80,000-70,000 mcf. gas	$1.5 million	Under Constr.	June 30, 1951	.....	Brown & Root	Brown & Root
Taylor Refining Co.	Corpus Christi, Texas	T.C.C. Unit	10,000 bbls.	.....	Contracted	July, 1951	Socony-Vacuum	Lummus	Lummus
Taylor Refining Co. and Mayfair Minerals, Inc.	Port Isabel, Tex.	Platforming Unit	4,000 bbls.	.....	Under Constr.	.....	U.O.P.	U.O.P.	.....
*Texas City Refining, Inc.	Texas City, Texas	Reactivation Houdry Cat. Crk and HF Alkylation	30,000 bbls.	$600,000	Under Constr.	April, 1951	U.O.P.	Staff	Staff
*Union Oil Co. of California	East White Lake, La.	440 hp. Comp. Sta.	.....	.....	Completed	Feb., 1951	.....	Delta	Delta
*Union Oil Co. of Calif.	Vinton, La.	440 hp. Comp. Sta.	.....	.....	Completed	.....	.....	Delta	Delta
*Union Oil Co. of Calif.	Tigre Lagoon, La.	Condensate Stabilizing Fac.	2,000 bbls.	.....	Completed	.....	.....	Delta	Delta
*United Carbon Co.	Shamrock, Texas	Carbon Black Plt.	66,800 lbs.	1.5 million	Under Constr.	May 1, 1951	.....	.....	.....
United Gas Pipe Line	Sterlington, La.	Dehydration	725,000 mcf	.....	Under Constr.	.....	.....	.....	Staff
*United States Rubber Co.	Baton Rouge, La.	Buna W Rubber Plt. Expan.	82,200 lbs.	.....	Planning	.....	.....	.....	.....
ROCKY MOUNTAIN									
New Mexico Asphalt and Refining Co.	Artesia, N.M.	Ptg. TCC Unit, Cat. Poly Unit	6,000 bbls. 200 bbls.	.....	Under Constr.	Aug., 1951	Socony-Vacuum Hydro Ren.	.....	Sveco Sveco
*Oriental Refining Co.	Denver, Colo.	Perro Cyclovercion Unit	1,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Pan Am Southern Corp.	El Dorado, Ark.	Fluid Cat. Crk., Vapor Unit	.....	.....	Completed	.....	.....	.....	.....
Pan-Am Southern	El Dorado, Ark.	Cat. Crk., Vap. Recov.	9,000 bbls.	$2.7 million	Completed	.....	.....	.....	.....
*Phillips Petroleum Co.	Woods Cross near Salt Lake City, Utah	Vac. Plt., Gas Plt.; Cat. Crk. Storage	.....	.....	Const. Summer 1951	July, 1952	.....	.....	.....
The Standard Oil Co. of N. Dakota	Grand Forks, N. Dakota.	Refinery	2,000-2,500 bbls.	.....	Planning	.....	.....	.....	.....
WEST COAST									
*General Petroleum Corp.	Torrance, Calif.	Chem. Fert Process	11 tons	$250,000	Completed	.....	.....	Fluor	Fluor
Hancock Oil Co.	Long Beach,	Ethylene Glycol	60,000 lbs.	.....	Considering	.....	.....	Badger	Badger
Shell Chemical	Pittsburgh, Calif.	Increase Ammonia Prod.	.....	.....	Under Constr.	May, 1951	.....	Staff	Staff
*Shell Chemical Co. Corp.	Shell Point, Calif.	Synthetic Ammonia Plt.	.....	.....	Planning	.....	.....	.....	.....
**"Same"	"Same"	Refinery	25,000-50,000 bbls.	$20 million	Planning	.....	.....	.....	.....
*Shell Chemical Corp.	Dominguez, Calif.	Added MIBK Prod. Capacity	.....	.....	Under Constr.	3rd Qtr., 1951	.....	Braun	Braun
*Shell Chemical Corp.	Martinez, Calif.	Octyl, Formal Plt Expansion	.....	.....	Under Constr.	July, 1951	.....	Bechtel	Bechtel
Standard Oil of Calif.	Richmond, Calif.	Vac. Tower TCC to Houdry	55,000 bbls. 45,000 bbls.	.....	Approved Engineering	May, 1951 May, 1951	Houdry	Staff	Bechtel
Standard Oil Co. of Calif.	Richmond, Calif.	Vac. Flasher	55,000 bbls.	.....	Contracted	May, 1951	.....	.....	Kellogg
*Standard Oil Co. of Calif.	El Segundo, Calif.	Reactivation of Butadiene Plt.	.....	.....	Completed	.....	.....	.....	Pet. Maint.
*Standard Oil of Calif.	El Segundo, Calif.	Benzene Plt.	850 bbls. Benzene, 2,300 bbls. Toluene	$10 million	Designing	Mid 1952	U.O.P.	.....	.....
Union Oil Co. of Calif	Bren Olinda, Cal.	Research Plt.	.....	$5 million	Projected	July, 1951	.....	Austin, Field and Fry	Walker
Union Oil Co.	Los Angeles, Calif.	Fluid Cat. Crk. Unit	28,000 bbls.	.....	.....	.....	.....	.....	.....
Union Oil Co. of Calif.	Edmonds, Wash.	Asphalt Refining	65,000 tons Annually	.....	Under Constr.	June, 1951	.....	Bechtel	Bechtel
*U. S. Navy and Standard Oil of Calif.	Elk Hills, Calif.	Nat. Gas Plt.	80 Mmcf.	.....	Planned	April, 1952	.....	.....	.....
*Wilshire Oil Co.	Norwalk, Calif.	Cat. Crk., Poly Unit Vac. Unit	20,000 bbls.	$2 million	Completed	April, 1951	U.O.P.	U.O.P.	Pet. Maint.
FOREIGN									
Canada									
British American Oil, Ltd.	Edmonton, Alberta	Refinery Offsite Facilities	.....	.....	Contracted	June 1, 1951	.....	Staff	Burns
British-American	Moose Jaw, Sask.	Cat. Crk., Coker Thermal Crk., Cat. Poly., Utilities	10,000 bbls.	$5.5 million	Under Constr.	Dec., 1951	U.O.P. (Cat. Crk. & Cat. poly.)	Pro. Eng	Pro. Eng.
*British American Oil and Shawinigan Chemicals	Montreal East, Canada	Petro Chemical Plt.	.....	.....	Planning	.....	.....	.....	.....
British-American	Edmonton, Alberta	Refinery	5,500 bbls.	.....	Under Constr.	Early, 1951	.....	Can. Kellogg	Can. Kellogg
*Canadian Chemical Co.	Edmonton Area, Alberta, Canada	Petro Chemical Plt.	.....	$40 million	Planning	.....	.....	.....	.....
Canadian Oil Refineries	Fromsfield, Ont.	Refinery Plat. Unit	20,000 bbls. 2800 bbls.	$18 million	Under Constr. Planned	April, 1952	..... U.O.P.	Can. Kellogg U.O.P.	Can. Kellogg, Procon

• Continued on page 147

More Gas...and Liquid...Volume

BS&B Horizontal Separator . . .

The Engineered "Bump" on the Flow Line



- Engineered for high capacity and efficiency by combining:
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  - Streamlined horizontal travel for gravitational separation.
  - Efficient mist extractor for final scrubbing.
  - Rugged dependable BS&B controls.
  - Ease of installation.

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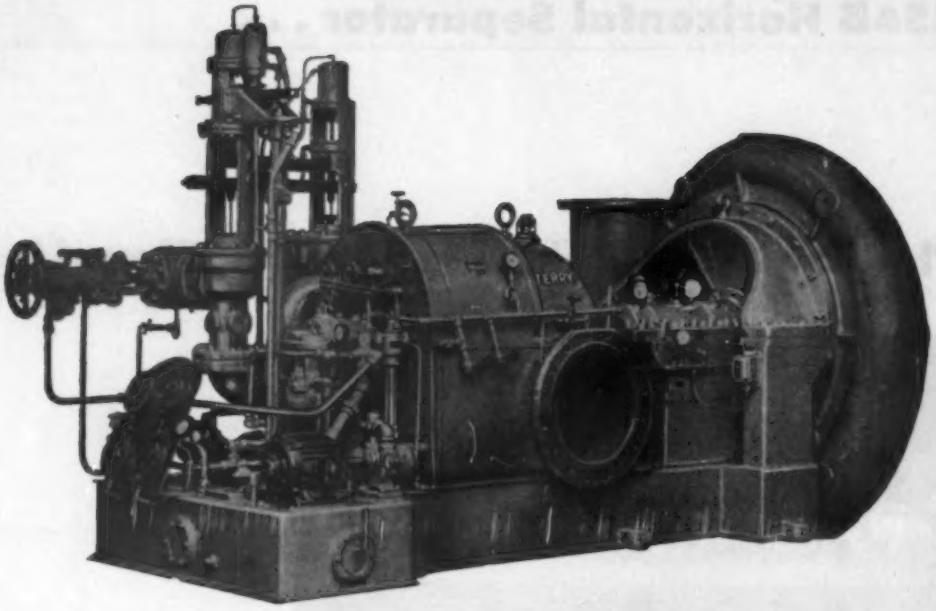
The TERRY TURBINE



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2. Straight, low-pressure, condensing — putting to work excess low-pressure steam.
3. Mixed pressure — using the low-pressure steam available, with only enough high-pressure steam required to drive the compressor
4. Condensing bleeder operation — providing clean, low-pressure steam for heating or process work

. . . and the speed under any of these conditions can be varied from 2800 to 4750 rpm.

This is but one example of many unusual combinations developed by Terry to meet out-of-the-ordinary requirements in turbines up to 2000 hp. Information on a special-purpose turbine for your specific requirements will be gladly furnished.

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THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Dominion Tar & Chemical Co., Ltd.	Montreal East, Canada	Petro Chemical Plt.	.....	$5 million	Planning	End 1952	.....	.....	Badger
Brassior Refs., Ltd.	Lloydminster, Alberta	Inc. Capacity	2,000 bbls.	.....	Under Constr.	1950	.....	.....	.....
Brassior Refs., Ltd.	Lloydminster	Inc. Capacity	1,800 bbls.	.....	Design	Spring, 1951	.....	.....	.....
Godfrey L. Cabot	Sarnia, Ont.	Carbon Black Plt.	.....	$1 million	Planning	.....	.....	.....	.....
Imperial Oil, Ltd.	Regina, Saskatchewan	Desalting Unit	16,000 bbls.	.....	Planned	Early 1951	Howe-Baker	Staff	Staff
Imperial Oil	Winnipeg	New Refinery	10,000 bbls.	$10 million	Under Constr.	May, 1951	.....	Canadian Kellogg	Canadian Kellogg
Imperial Oil Co., Ltd.	Edmonton, Alberta	Fluid Cat. Crk., Gas Recov. Plt. Vac. Dist. Unit	20,000 bbls.	$5 million	Under Constr.	Summer 1952	.....	Standard Oil Dev. Co.	Foster Wheeler
*Imperial Oil, Ltd.	Sarnia, Canada	Fluid Cat. Crk., Dist., Light Ends Recov.	71,000 bbls.	.....	Planning	.....	.....	.....	.....
*"Same"	"Same"	20 Storage Tanks	3 million bbls.	.....	Planning	.....	.....	.....	.....
Imperial Oil	Edmonton, Alta.	Desalting Unit	22,000 bbls.	.....	Planned	Early 1951	Petreco	Staff	Staff
McColl Frontenac Oil Co., Ltd.	Edmonton, Alta.	Crd. Processing Cat. Crk.	5,500 bbls.	$10 million	Contracted	1951	.....	Foster Wheeler	Foster Wheeler
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding	.....	.....	Projected	.....	.....	.....	.....
Supreme Refineries, Ltd.	Hanna, Alta.	Nat. Gaso. Plt.	1,000 mcf	$100,000	Abandoned	.....	.....	Staff	Staff
Supreme Refineries	Ogden, Alta.	Refinery	1,000 bbls.	$100,000	Under Constr.	June, 1951	.....	Staff	Staff
Supreme Refineries, Ltd.	Ogden, Alta.	Asphalt Plt.	.....	.....	Planning	.....	.....	.....	.....
Latin America									
Administration Nacional Combustibls Alcohol y Portland	Montevideo, Uruguay	Lube, Atmospheric Unit, Asphalt Units	7,500 bbls.	.....	Completed	Spring, 1951	.....	Foster Wheeler	Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brasil	Thermal Cracking Refinery	2,500 bbls.	$5 million	Completed		.....	Kellogg	Kellogg, Staff
Conselho Nacional do Petroleo	Cubatao, Sao Paulo, Brasil	Therm. Crk. Ref. Reforming, Vis. Breaking Cat. Poly.	45,000 bbls.	.....	Under Constr.	End, 1952	.....	Hydrocarbon	Fivas-Lilla & Schneider, Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brasil	Ref. Expn. Cat. Poly. L.P.G., Plt.	2,500 bbls.	$3.5 million	Contracted	June, 1952	.....	.....	Kellogg
The Corporacion de Fomento de la Produccion	Concon, Valparaiso, Chile	Refinery	14,000 bbls.	$9 million	Planning	1953	.....	.....	.....
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring	.....	.....	Planning	.....	.....	.....	.....
Empresa Nacional del Petroleo	Cerro Manantiales, Tierra del Fuego	Crude Stabilizer, Nat. Gas., L.P. G. and Re-cycling	30,000 mcf gas	$2.6 million	Under Constr.	Nov., 1951	.....	Hudson Eng.	Staff under Hudson
Ipiranga S.A. Cia Brasileira de Petroleos	Rio Grande, Brasil	Therm. Crk. Ref.	2,000 bbls.	.....	Authorized	1952	Foster Wheeler	.....	.....
*Petroleos Mexicanos	Ciudad Madero, Mexico	Desulfurization Units	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Tamaulipas, Ciudad Madero, Mex.	Enlarge Refinery Capacity	47,280 bbls.	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Tamaulipas, Arbol Grande Pet., Mex.	Enlarge Refinery	16,000 bbls.	.....	Planning	.....	.....	.....	.....
*Petroleos Mexicanos	de Marzo, Mex.	Desulfurization Units	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Mata Redonda, Vera Cruz, Mex.	Improvements	9,000 bbls.	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Improvements to Skimming Plant	3,100 bbls.	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maint.	.....	$13 million	Under Constr.	Spring, 1951	.....	McKee	McKee
*Petroleos Mexicanos	Reynosa, Mex.	Expansion	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Reynosa, Mex.	Refinery	4,000 bbls.	$1 million	Completed	.....	.....	Staff	Staff
*Petroleos Mexicanos	Salina Cruz, Mexico	Refinery	.....	.....	Planning	.....	.....	.....	.....
*Petroleos Mexicanos	Salamanca, Mex.	Lube Oil and Paraffin Plt.	.....	.....	Planning	.....	.....	.....	.....
Phillips Oil Co.	San Roque Fld., Anzoategui, Venezuela	Refinery, Wax Plt.	2 mln. lbs. wax/ year	.....	Planning	1952	.....	.....	.....
*Phillips Oil Company	San Roque Fld., Anzoategui, Venezuela	Crude Stab. and Pressure Maint. Plt.	10,000 bbls. and 38 Mmcf.	.....	Planning	.....	.....	.....	.....
*"Same"	"Same"	Crude Distill.	3,000 bbls.						
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	35,000 bbls.	$30 million	Projected	1st Qtr., 1951	Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	.....
Refinaria de Petroleos do Distrito Federal S.A.	Rio de Janeiro, D. F. Brasil	Therm. Crk.	10,000 bbls.	.....	Authorized	.....	.....	.....	Fivas, Lilla, Schneider, Staff Foster Wheeler
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref.	20,000 bbls.	.....	Authorized	.....	.....	P.A. Hydro. Res.	Czech, Pact. Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.	.....	Referred	.....	.....	.....	.....
Shell Co. of Venezuela	Cardon, Ven.	Comprehensive Refg.	26,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Trinidad Leaseholds, Ltd.	Trinidad	Refinery addition	.....	$200,000	Designing	.....	.....	H.W.P.	H.W.P.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$34 million	Design	1951	.....	Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Gaso. Treating	30,000 bbls.	$3.8 million	Under Constr.	Spring, 1951	.....	Houdry Process Cat. Constr.	Cat. Constr.
YPF Bolivianos	Cochabamba, Bolivia	Topping & Reforming Units	5,000 bbls.	$7.2 million	Completed	.....	.....	Foster Wheeler	Foster Wheeler
YPF Boliviano	Sucre, Bolivia	Additional Unit	2,000 bbls.	.....	Under Constr.	2nd Qtr., 1951	.....	.....	Foster Wheeler
Europe and Africa									
Anglo-American Oil	Fawley, Eng.	Refinery	110,000 bbls.	$150 million	Under Constr.	Jan., 1953	.....	Foster Wheeler	Foster Wheeler

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Anglo-American	Fawley, Eng.	Poly Unit	.....	.....	.....	.....	.....	.....	.....
Anglo-American	Fawley, Eng.	SO_2 Extraction	13,000 bbls.	.....	Design	.....	.....	Badger	Badger
Anglo-American	Fawley, Eng.	Fluid Cat. Crk.	1 million gals.	.....	Under Constr.	.....	.....	Foster Wheeler	Foster Wheeler
Anglo-Iranian Oil	Isle of Grain, Eng.	New Refinery	40,000 bbls.	.....	Under Constr.	End, 1953	.....	Badger, Lummus, Kellogg	Badger, Lummus, Kellogg
Anglo-Iranian Oil Company	Hamburg, Germany	Topping Unit	5,500 bbls.	.....	Completed	.....	.....	Foster Wheeler	.....
Anglo-Iranian Oil Company	Hamburg, Germany	Winkler-Koch Combination Topping, Cracking, Reforming	8,800 bbls.	.....	Completed	.....	.....	.....	.....
Anglo-Iranian Oil Company	Hamburg, Germany	Gas Recov. and Stabilization Plts., Plumbite Treaters	.....	.....	Completed	.....	.....	.....	.....
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plt.	.....	$50-60 million	Contracted	.....	.....	Hydro. Res.	.....
Aquila, S.A.	Trieste, Italy	Prop. Deasph., Furf. Sol. Rel. MEK Dewax. Contact Filtr. Dist. & Blending Plt.	100 tons 95 U1 Lubes & Bright Stocks 8 tons all Paraffin Waxes	$7.9 million	Under Constr.	Spring, 1951	Juik, Texaco	Badger	Badger
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	800 bbls.	$7.9 million	Design	Spring, 1951	Juik, Texaco	Badger	Badger
*Azienda Italiana Petroli Albania	Ancona, Italy	Oil Refinery	500,000 tons Crude Annual	.....	Completed	.....	.....	Breda	Breda
Azienda Generale Italiana Petroli	Cortemaggiore Field, Italy	Gasoline Extraction Plt.	105 Mmcf Pt.	$3.5 million	Under Constr.	End 1951	.....	J. F. Pritchard & Co.	North American Pet. Gas Corp.
Bataafsche Pet. Mi.	Pernis, Holland	Expansion	73,500 bbls.	.....	Under Constr.	2nd Half, 1951	.....	.....	.....
*William Briggs & Sons, Ltd.	Camperdown, Scotland	Crude Dist. Fac.	1,000 bbls.	.....	Under Constr.	Early 1953	.....	.....	.....
British Petroleum Chem.	Grangemouth, Scotland	Petrochem	.....	.....	Completed	.....	.....	Stone & Webster	Stone & Webster
*California-Texas Oil Co.	Pernis, Netherlands	Expanding Refinery	26,000 bbls.	.....	Under Constr.	Early 1952	.....	Various Local	Various Local
Shell-Berre	Berre, France	Expansion	65,000 bbls.	$31.6 million	Under Constr.	Early, 1952	.....	.....	.....
Shell-Berre	Petit Couronne	Teepol Plt.	25,000 tons/yr.	.....	Under Constr.	1st Qtr., 1951	.....	.....	.....
Shell-Berre	Petit Couronne, France	Lube Unit	.....	.....	Planned	.....	.....	.....	.....
Cie Francaise de Raffinage	La Mede, France	Cat. Crk., Gas Recov. System	11,500 bbls.	$10 million	Authorized	1953	.....	.....	.....
Cie Francaise de Raffinage	Gonfreville, France	Gas Recov. System	.....	.....	.....	.....	.....	.....	.....
Cie. Francaise de Raffinage	Gonfreville, France	Therm. Reform., Prop. Deasp., Furf. Trtng.	4,750 bbls.	.....	Under Constr.	1952	Texaco & Juik	Kellogg	Local
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.	.....	Design	1951	Texaco	Kellogg-Lummus	.....
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife, Canary Islands	Propane-Butane Fractionating	204 bbls.	$100,000	Under Constr.	Spring, 1951	.....	U.O.P.	U.O.P.
*C.E.P.S.A.	Santa Cruz de Tenerife (Canary Islands)	Reforming Unit	6,000 bbls.	$1 million	Planned	.....	U.O.P.	U.O.P.	Foster Wheeler
C.E.P.S.A.	Canary Islands	Propane-Deas.	700 bbls.	$300,000	Under Constr.	Spring, 1951	Standard Oil	Foster Wheeler	Foster Wheeler
*Compania Espanola Petroleos, S. A.	Santa Cruz de Tenerife (Canary Islands)	Percolation Unit	400 bbls.	.....	Under Constr.	Spring, 1951	.....	.....	.....
Condor, S.P.A. Per l Industriale Pet. Chemica	Rho, Italy	New Refinery	1.5 mln. tons/yr.	.....	Under Constr.	1951	.....	.....	.....
*"Condor," Sp. A. per l'Industria Petrolifera e Chimica	Rho, Italy	Atm. Dist. Plt.	30,000 bbls.	.....	Under Constr.	.....	.....	Badger	.....
*"Same"	"Same"	Feed Prep., TCC Unit	15,000 bbls. 10,000 bbls.	.....	Under Constr. Under Constr.	.....	.....	Badger Badger	.....
*"Same"	"Same"	Recov. Purification Plt., Adm. Bldg., Pwr. House	.....	.....	Under Constr.	.....	Sac. Vac.	Badger	.....
Danish Government	Denmark	Refinery	21,000 bbls.	.....	Planned	.....	.....	.....	.....
Deutsche-Amerikanische Petro-Gesellschaft (Esso)	Hamburg-Harburg, Germany	Cracking Plt.	8,843 bbls.	.....	.....	4th Qtr., 1953	.....	.....	.....
*Deutsche Erdoel, A. G.	Heide, Germany	Cracking Fac.	†2,800 bbls. Gasoline ††1,250 bbls. Diesel	.....	.....	Dec., 1951	.....	.....	.....
Egyptian Government	Cairo, Egypt	Crude Plt.	.....	.....	.....	.....	.....	Lummus	Lummus
Egyptian Government	Suez, Egypt	Ins. Refn. Cap.	35,000 bbls.	$2,500,000	Planning	.....	.....	.....	Lummus
Esso Standard Refg.	Antwerp, Belg.	New Refinery Incl. Crker.	35,000 bbls.	.....	Authorized	July, 1953	.....	Standard Oil Dev. Co.	.....
Gewerkschaft Erdoel-Raffinerie Emsland	Near Lingen, Germany	Refinery	11,535 bbls.	$8,670,000	.....	4th Qtr., 1952	.....	.....	.....
Industrie Chimiche Italiane Petroli	Manisa, Italy	Crude	4,500 bbls.	.....	.....	.....	.....	.....	.....
Industria Petrolifera e Chimica	Milan, Italy	Gasoline Fuel Oil Plt.	20,000 bbls.	.....	.....	.....	.....	Dr. Calogero Inglegio	.....
Industrie Raffinazione Oli Minerali (IROM)	Porto Marghera, Italy	Crk. equipment	4,000 bbls.	$2 million	Planning	.....	.....	.....	.....
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit	.....	.....	Under Constr.	Spring, 1951	.....	Kellogg	Kellogg
L'Alliance Petrolina	Antwerp, Belg.	Refinery	21,000 bbls.	.....	Planned	.....	.....	.....	.....
Manchester Oil Refinery, Ltd.	Partington, England	New Lube Refinery	30,000 bbls.	.....	Projected	.....	.....	.....	.....
Monsanto Chemical Co.	Britain	Add Polystyrene	.....	.....	Under Constr.	July, 1951	.....	Staff	Staff
*National Oil Refineries, Ltd.	Llandarcy, Wales	Vacuum Unit	17,000 bbls.	.....	Under Constr.	End, 1951	.....	Badger	Badger
*"Same"	"Same"	Propane Deasphalting	3,500 bbls.	.....	Under Constr.	End, 1952	J.U.I.K.	Badger	Badger
*"Same"	"Same"	Furf. Ext.	1,250 bbls.	.....	Under Constr.	End, 1952	Texaco	Badger	Badger
*"Same"	"Same"	M.E.K. Dewaxing	1,700 bbls.	.....	Under Constr.	End, 1952	Texaco	Badger	Badger
*"Same"	"Same"	SO_2 Kerosene Ext.	2,000 bbls.	.....	Under Constr.	Mid, 1951	.....	H.W.P.	Staff

* Continued on page 151

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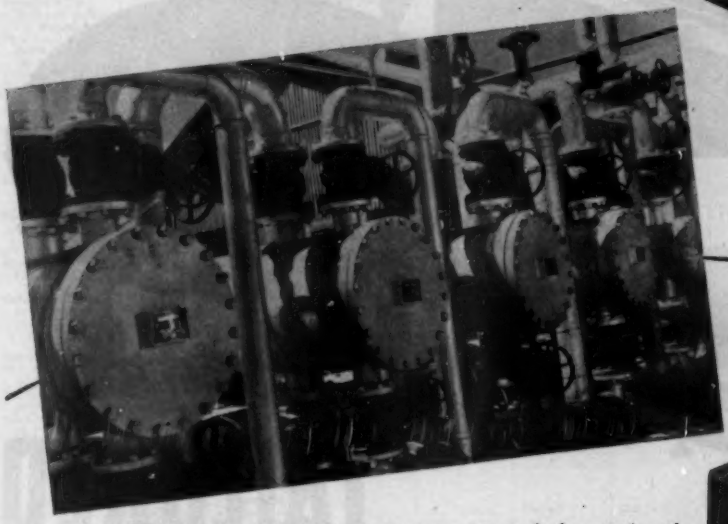

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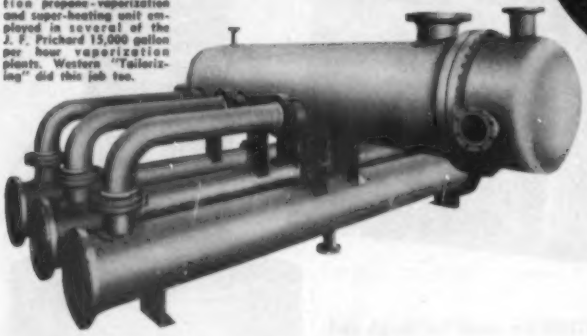

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COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*National Oil Refineries, Ltd.	Llandarcy, Wales	Additional Boilers	.....	.....	Under Constr.	1952	.....	Ewbank & Partners	.....
*"Same"	"Same"	Generating Plant	13,000 KW	.....	Authorized	1953	.....	Ewbank & Partners	.....
National Oil Refineries, Ltd.	Llandarcy, South Wales, England	Cat. Crk.	10,000 bbls.	.....	Under Constr.	Early 1953	.....	Kellogg	Kellogg
*A/S Norsk Amerikansk Mineralolskompagni	Vallo, near Tonberg, Norway	Lube Oil, Asphalt	1,000 bbls.	.....					
Pechelbronn, S.A. E. M.	Merkwiller, France	Capacity Increase	1,530 bbls.	.....	Authorized	1951	.....	.....	.....
Permolio, S.P.A., Raffinerie Italiane Olii Minerali	Genoa, Italy	Cat. Cracker	1,530 bbls.	.....	Planning	4th Qtr., 1951	.....	Foster Wheeler	Foster Wheeler
Permolio, S.P.A., Raffinerie Italiane Olii Minerali	Milan, Italy	Perco Reforming Unit	350 bbls.	.....	Planning	Early 1951	.....	.....	.....
Permolio	Rome, Italy	Cat. Cracker	1,530 bbls.	.....	Planning	4th Qtr., 1951	.....	Foster Wheeler	Foster Wheeler
Petrochemineh, Ltd.	Partington, England	Petrochemineh	2,000 bbls.	$16 million	Under Constr.	Spring, 1951	Petrocarbon	Petrocarbon	Petrocarbon
Phillinck, Ltd.	Avonmouth, England	Carbon Blk. Plt.	137,000 lbs.	$5 million	Contracted	May, 1951	Phillips	H.W.P.	H.W.P.
Raff. Belge de Petroleos, S.A.	Antwerp, Belg.	Topping Unit	8,000 bbls.	$1,000,000	Contracted	Sept., 1951	.....	H.W.P.	Chaurobel
Raffinerie Belge	Antwerp, Belg.	Atmos., Vac. Distill.	7,000 bbls.	$1.5 million	Planning	June, 1951	.....	.....	.....
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million	.....	.....	.....	Separator-Noble	.....
Raffinerie Siciliane Olii Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.	.....	Under Constr.	Spring, 1951	U.O.P.	U.O.P., Delta, Staff, Separator-Noble	Staff
*Refineria de Petroleos, S.A.	Cartagena, Spain	Four cell induced draft cooling tower	.....	.....	Under Contract	.....	.....	.....	Foster Wheeler
Refineria de Petroleos de Escombreras, SA., (REPESA)	Escombreras, Spain	Refinery Atmos. Dist., Therm. Reformer, Cat. Poly., Lube Plt.	30,000 bbls.	$30 million	Under Constr.	Mid 1952	.....	Foster Wheeler	Foster Wheeler
REPESA	Cartagena, Spain	Lube Plt.	.....	.....	Projected	.....	.....	.....	.....
*S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Topping Unit	10,000 bbls.	.....	.....	.....	.....	.....	.....
S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Cracking Unit	5,000 bbls.	.....	.....	.....	.....	.....	.....
S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Reformer	2,800 bbls.	.....	.....	.....	.....	.....	.....
Scottish Oils, Ltd.	Grangemouth, Scotland	Stage I: 1 Pipe Still Distill., Phos. Acid Trig. Plt. Steam Boil. & Power Plt.	1.5 min. tons per yr. 20,000 kw.	$33.6 million	Under Constr.	Early 1951	.....	Kellogg	Kellogg
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Gas Rec. Vac. Distill., Cat. Poly Plt., & Trting Plt.	.....	.....	Planned	Mid., 1952	.....	.....	.....
Scottish Oils, Ltd.	Grangemouth, Scotland	Buoyancy Foundations	.....	.....	Under Constr.	Spring, 1951	.....	Rendel Palmer and Tritton	.....
Shell Chemical Mfg. Co., Ltd.	Stanlow, Eng.	Taepol Plant Extension	75,000 tons per year	.....	Under Constr.	Spring, 1951	.....	.....	.....
*Shell Oil	Shell Haven, England	Reforming Unit	110,000 bbls.	.....	Under Constr.	May, 1951	.....	.....	.....
*Shell Oil	Shell Haven, England	Feed Prep.	116,000 bbls.	.....	Projected	.....	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	60,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refining	30,000 bbls.	$26.6 million	Completed	.....	.....	.....	.....
*Shell Union Oil	France	Wharf, tankage detergent, Acetone-Syn Iso-Propyl Plts	.....	$6 million	Under Constr.	Late 1951	.....	.....	.....
Societe Generale Des Huiles de Petrole	Dunkirk, France	Crude Reform.	53,000 bbls.	$36,103,000	Under Constr.	Mid., 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Societe Generale	Dunkirk, France	Furl. Ref. Sol. Dewax., Wax Fractn.	2,400 bbls.	.....	Under Constr.	Mid., 1951	Texaco	Lummus	Lummus
Societa Industrial Belge des Petroles	Antwerp, Belg.	Crd. Crk. Ref.	30,000 bbls.	.....	Under Constr.	Mid., 1951	.....	Kellogg	Kellogg
*Societa per l'Industria del Petrolio	La Spezia, Italy	Expansion	30,000 bbls.	.....	Under Constr.	Mid, 1953	.....	.....	.....
*Societa per Azioni Reffineria Padana Olii Mineral	Milan, Italy	Refinery	10,000 bbls.	$30 million	Planned	.....	.....	.....	.....
Societe Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load Facilities	11,000 bbls.	$9.4 million	Contracted	.....	.....	H.W.P.	H.W.P
Societa per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	12,000 bbls.	$15 million	Under Constr.	Fall, 1952	.....	Badger	Badger
Socony-Vacuum Francaise	Frontignan, France	T.C.C. Unit	.....	.....	Planning	.....	Socony-Vacuum	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	.....	Under Constr.	Feb., 1951	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding Visbreaker	900 lbs.	.....	Under Constr.	Early, 1951	.....	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	.....	.....	.....	.....	April, 1951	.....	Staff	Staff
Stand-Asienda Gen. Indro. Comb. (Stanic)	Leghorn, Italy	Ref. Expan.	12,000 bbls.	.....	.....	End 1953	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Stanic	Bari, Italy	Add Capacity	12,000 bbls.						
Standard Francaise des Petroles	Port Jerome, France	Dewaxing Plant	1,200 bbls.	$6.4 million	Design	End 1951		S.O.D.	Foster Wheeler
Standard Francaise des Petroles	Port Jerome, France	Desaphalting Plant	1,800 bbls.		Design	End 1951		S.O.D.	
Standard Francaise des Petroles	Port Jerome, France	Cat. Crk.	10,000 bbls.	$10 million	Authorized	March, 1953			
Standard Oil Co., (N.J.)	Belgium	Dist. Crack	33,000 bbls.		Planned	Early 1953			
*Standard-Vacuum Ref. Co.	Wentworth, Durban, Union of S. Africa	Refinery	10,000 bbls.	$12.5 million	Planning	Late 1953			
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery		$30 million	Projected				
Vacuum Oil Co., Ltd.	London, Eng.	Oil Refinery	6.3 mln. bbls./ yr.	$28 million	Planning				
Vacuum Oil Co., Ltd.	Birkenhead, England	Grease Plt.		$1 million	Contracted	Early 1953		H.W.P.	H.W.P.
Vacuum Oil Co.	Coryton, Eng.	Lube Refinery	17,000 bbls.	$30 million	Under Constr.	Sept., 1953			
Near East									
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$3 million	Completed			Badger	Badger
Anglo-Iranian	Abadan, Iran	Cat. Cracker	30,000 bbls.		Under Constr.	1951		Foster Wheeler	Foster Wheeler
Anglo-Iranian	Abadan, Iran	Gas Recov., Stab.	22,000 mcf		Under Constr.	Spring, 1951		Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4.8 million	Under Constr.	Spring, 1951		Staff and Fluor	Fluor, Middle East, S.A.
Arabian American Consolidated Ref., Ltd.	Ras Tanura, S.A. Haifa, Palestine	Asphalt Plant Gen. Facilities Conversion of Kellogg Comb-Top. and Crk.	500 bbls. 35,000 bbls.	$1.35 million	Completed Planned	1951		Staff, Bechtel Badger	Staff
*Iraq Government	Baghdad Area	Refinery	24,000 bbls.	$19.6 million	Planning	Spring, 1954		Kellogg	
*Turkey Government	Ramandag Field	Refinery	3,000 bbls.	$3.5 million	Planning				
Far East									
Batavsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	80,000 bbls.		Under Constr.	Mid., 1951			
Batavsche Pet. Mij.	Pladjoe, Sumatra	Rehad. to Comprehensive Refg.	71,000 bbls.		Under Constr.	Early 1952			
*Batavsche Pet. Mij.	Tjepu, Java	Rebuild TEL Blending Unit & Dist. Unit			Planning				
Burmah Oil Co., Ltd.	Syriam, Burma	Furf. Sol. Dewax., Wax Mfg.	1,000 bbls.	$800,000	Designing		Texaco	Badger	
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	60 tons	$150,000	Engineered	Spring, 1951	Max Miller, Socony-Vacuum	Max Miller	
*KOA Oil Co., Ltd. (and) Calter Oil Co., Ltd	Marifu, Japan	Expansion of Vac. Unit, Contact Rerun Unit	Restricted to 3,000 BPCD		Under Constr.	Summer, 1951		Taisumi	Taisumi
*Kao Oil Co., Ltd.	Marifu, Japan	Solvent Dewaxing Plt.; Solvent Extracting Plt.			Design	1951-1952			
Mitsubishi Oil Co., Ltd.	Tokyo, Japan	Vacuum Distillation Unit	2,000 bbls.			1951			
Mitsubishi Oil Co., Ltd.	Tokyo, Japan	Solvent Extraction & Dewaxing Processes				1951			
Nippon Oil Co., Ltd.	Yokohama, Japan	Benzene-Ketone Dewaxing-Deoiling Unit							
Nippon Oil Co., Ltd.	Kudamatsu, Japan	Benzene-Ketone Dewaxing-Deoiling Unit							
Nippon Oil Co.	Japan	Lube Oil Refining			Under Constr.			Separator-Nobin	
Toa Nenryo Kogyo KK	Shimizu, Japan	Lube Oil Refg. Plants	5,000 bbls.		Completed				
*Toa Nenryo Kogyo	Wakayama, Japan	Thermal Crk. Plant	2,500 bbls.		Completed				
Pacific Refiners	Honolulu, Hawaii	Benzol Plt.	65 bbls.	$300,000	Completed			Fish Eng.	Fish Eng
*Standard-Vac. Oil Co.	Gerong, South Sumatra	Cylinder-Filling Plt.			Completed				
Toa Nenryo Kogyo, Ltd.	Wakayama, Japan	Cracking	2,500 bbls.		Designing	Spring, 1951			Staff
Oceania									
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery		$4.8 million	Under Constr.	Late 1951			
Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Luboil Plant			Projected				
Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Sel. Extrct Plt.							

* First appearance in tabulation. † Added capacity.

NOTE: Austin—Austin Co. Badger—E. B. Badger & Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Blaw-Knox—Blaw-Knox Construction Co. Bowden—W. H. Bowden. Braun—C. F. Braun Co. Breda—Breda Co., Milan, Italy. Brown Eng.—Brown Engineering Co. Brown & Lite—Brown & Lite Co. Brown & Root—Brown & Root Construction Co. Can. Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B.&I.—Chicago Bridge & Iron Works Co. Constr. Service—Construction Service Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. E.&A.—Ehrhart & Arthur, Inc. Ferguson—H. K. Ferguson. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Gaso. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Girdler—The Girdler Corp. Graff—Graff Engineering & Equipment Co. Graver—Graver Construction Co., Inc. Grebe & Doremus—Grebe & Doremus Process Co. Hammond—Hammond Iron Works. Harris—John W. Harris Associate, Inc. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Process, Ltd. Hydro, Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Knutson—Knutson Construction Co. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mahoney—Mahoney Contracting Co. Mason—Mason Brothers Construction Co. Mathews—Mathews Conveyor Co. McKee—Arthur G. McKee Co. Max. Miller—Max B. Miller & Co. Michael-Poling—Michael-Poling Construction Co., Inc. Montgomery—J. M. Montgomery & Co. P. A. Hydro Res.—Pan American Hydrocarbon Research, Inc. Parsons—The Ralph M. Parsons Co. Parco—Division Phillips Petroleum Co. Pet. Eng.—Petroleum Engineering, Inc. Pet. Maint.—Petroleum Maintenance. Petreco—Petroleum Rectifying Co. Pioneer—Pioneer Industrial Co. Poling and Bacon. Pritchard—J. H. Pritchard Co. Pro. Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. Rust Pro.—Rust Process Design Co. Schneider—Schneider & Co. Sears—Frederick Sears Corp. Sellitt—Summer S. Sellitt Co. S.O.D.—Standard Oil Development Co. State Eng—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Taisumi—Taisumi Engineering Co. Telfer-sen—Telfersen Construction Co. Texaco—Texaco Development Co. Trotti and Thompson. U.O.P.—Universal Oil Products Co. Utah—Utah Construction Co. Voorhees, Walker, Foley & Smith. Walker—P. J. Walker Co. Walco—Walco Engineering. West—P. S. West Construction Co. White—J. H. White Corp. Eng. Wigton-Abbott—Wigton-Abbott Corp. Wohlfeld—Wohlfeld Construction Co. Equally owned California-Texas Corp. and Socony-Vacuum Oil Co., Inc.

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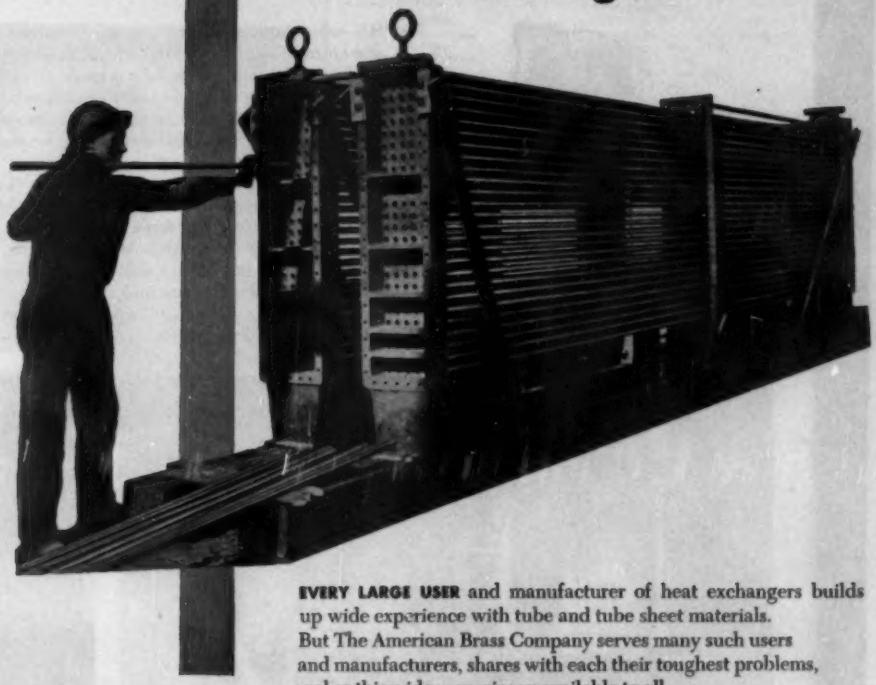

ANACONDA Arsenical Admiralty Tubes being installed in tube bundle at Lemont, Illinois plant of Globe Oil & Refining Co. Fortified against dezincification by the arsenic content, tubes of this ANACONDA Alloy are being used with good results in many types of petroleum refining and other process equipment.

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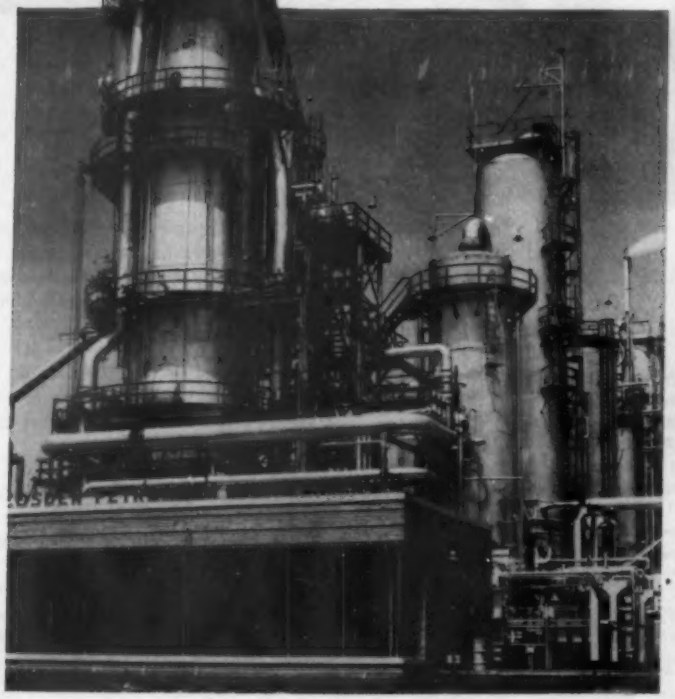

The towers of this new refinery are insulated with PC Foamglas, finished with corrugated aluminum. Foamglas comes in standard flat blocks, curved segments and beveled lags to fit many types of equipment. Insulation Contractor: The Aber Company, Inc., Houston, Texas.

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Preformed sections of PC Foamglas are available for standard pipe sizes and fittings. Installation is quick and easy. Photo courtesy of North Brothers, Atlanta, Ga.

PC Foamglas, on sides and head of this evaporator will help maintain the 280° to 320°F. temperatures required for drying "green" wood prior to creosoting. Photo courtesy of Taylor-Colquitt Company, Spartanburg, S. C.

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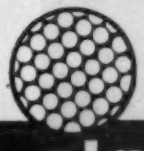

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CNGA committeeman (see sketch below) appear in this group, left to right: A. C. Lyles, R. A. Montague and H. O. Kruger

REFINER AUTHORS and Other Personalities

Perco Division Author

GEORGE M. BROONER, author of "Gasoline Plant Products Treating," page 95, is a native Kansan. At Southwestern College, Winfield, he majored in chemistry and geology, graduating in 1936. Following that Brooner studied at the University of Kansas graduate school for one year. Upon completion of his studies he was employed by Derby Oil Company Refinery at Wichita, Kans., as a chemist, and kept this position for one year before transferring allegiance in 1938 to the Perco Division of Phillips Petroleum Company.

On Distillation Analysis

WALTER J. PODBIELNIAK, author of "Precise Fractional Distillation Analysis," page 85, completed his early education in Buffalo, N. Y., and then worked briefly in the research chemical engineering department of National Aniline Company at Buffalo before turning instructor in chemistry physics, mathematics, and according to his wife, piano, at National Alliance College from 1921-1923.

He entered the University of Michigan, Chemical Engineering Department, in 1923, and found that his credits were in such a tangle that, to quote Mrs. Podbielniak: "he would ordinarily have been assigned half time to Ann Arbor high school and half time to graduate school to balance out his unorthodox scattering of knowledge." However, Podbielniak was granted freedom in selecting his courses and later was recruited by E. H. Leslie of the University staff and consultant to Phillips Petroleum Company to assist the Company in preparing a defense against a patent infringement suit. Phillips Petroleum Company had a weak case at the time but Podbielniak succeeded in discovering methods and apparatus under the guidance of Leslie and after much research and preparation was helpful in enabling Phillips Petroleum to win the suit. In 1927 he returned to Michigan to work on his degree which he completed in record time. Graduation day he collected a debt from Miss Wladzia Gajda who had wagered that he could not complete his Ph.D. by June 1928. She paid off her wager by saying "I do."

In Huntington Beach, Calif., he had installed a low-temperature fractionating apparatus for plant control for O. C. Field Gasoline Company in the spring of 1928. It had apparently been very successful for on their honeymoon trip the Podbielniaks installed similar apparatus for The Texas Company and for Superior Oil Company.

Homeward bound in 1929, they stopped in Tulsa and Podbielniak with the assistance of his wife, set up an analytical and research laboratory which they continued until 1934 when they decided to move to a more central location, namely Chicago.

Podbielniak is the author of numerous technical articles and holds patents in the United States and seven foreign countries.

Chemical Process Inventor Tries Pen

INVENTOR and co-inventor of various chemical processes is F. J. Bartholomew, author of "Spent Acid Recovery Offers Solution for Tight Sulfur Supply," page 101.

A public school teacher for two years, he quit teaching and became a student again at Lehigh University, graduating with a B.S. Chemistry degree in 1913.

Following his graduation he served two years as assistant chief chemist U.S. Nitrate Plant 2, Muscle Shoals, Ala., and then was given charge of research and development of the Chemical Construction Corporation until 1938. In 1937 he received an honorary technical degree, Chemical Engineering. A member of Tau Beta Pi, Bartholomew is at present assistant secretary and sales executive for Chemico.

On Gas Determination

A. C. LYLES, one of the collaborating authors of "Determination of Carbon Dioxide and Oxygen in Natural Gases," page 93, has been working with gas since 1927 when he joined General Petroleum Corporation as a gas tester after receiving his graduate degree from Cornell University. At General Pet's by 1930 he was chief chemist at the company's Santa Fe laboratory and then four years later resigned to accept an opening at Kettleman North Dome Association as gas engineer. He returned to General Petroleum's laboratory at Santa Fe in 1943 and now is senior gas engineer. Lyles is a member of Alpha Xi Sigma, and since 1927 has been a

W. J. PODBIELNIAK | GEORGE M. BROONER | F. J. BARTHOLOMEW | GEORGE F. RUSSELL

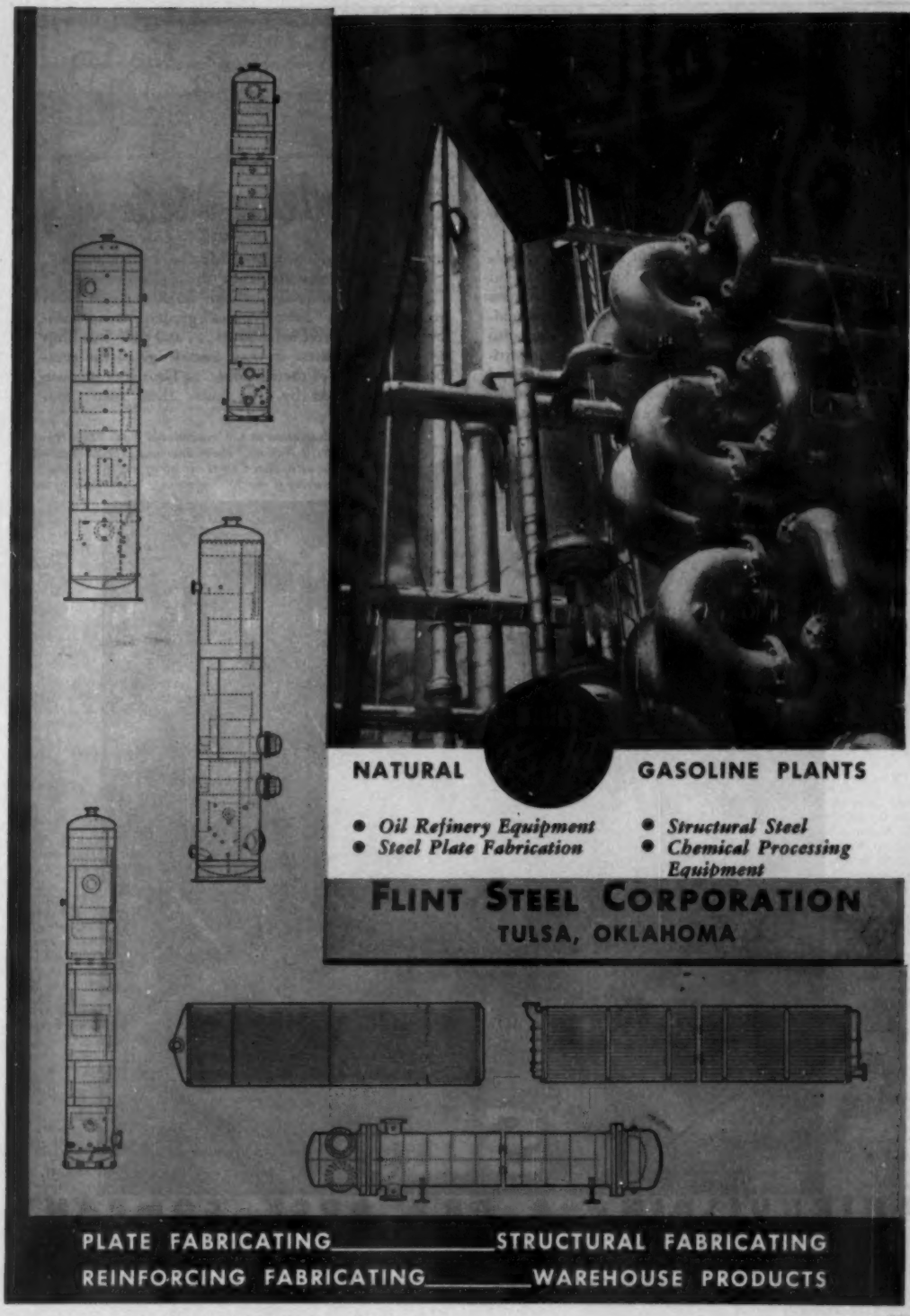
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Illustration at top, reproduced from "The History of All Nations," shows ancient Egyptian shipbuilding as depicted on the tomb of Ti, at Sakhara. In contrast is the 55' regenerator being built by Sun.

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member of CNGA, being chairman of its Technical Committee.

R. A. Montague, chairman of CNGA's Orsat Analysis Committee, at present is chief chemist of Standard Oil of California's Santa Fe Laboratory. "Monte" received both his Bachelor's and Chemical Engineering degrees from Stanford University before going to work with Standard as a chemist in 1922. He is a member of Alpha Xi Sigma.

Other members of the Orsat Analysis Method Committee include: J. E. Adams, Signal Oil & Gas Company; J. T. Brustad, Richfield Oil Corporation; R. J. Corbet, General Petroleum Corporation; W. E. Escobar, The Texas Company; R. U. Fisher, Tide Water Associated Oil Company; R. C. Kendig, Shell Oil Company; H. O. Kruger, Southern California Gas Company; N. K. Senatoroff, Pacific Lighting Gas Supply Company; E. E. Shafer, Jr., Gas Research & Engineering; and W. W. Warneke, C.C.M.O. Company.

California Veteran Writes on Compressors

PROFESSIONAL activities of Robert S. Ridgway, who wrote "Preventive Maintenance for Engines and Compressors," page 64, since receiving his degree at the California Institute of Technology in Pasadena in 1924 have been chiefly concerned with internal combustion and compressor engineering. Ridgway joined the Standard Oil Company of California in 1925, and has since worked with the natural gasoline department. He has held the position of mechanical engineer since 1928.

As Standard of California has expanded its natural gas and gasoline activities Ridgway has been concerned with problems arising in both gas engine and compressor operation, maintenance, installation and design, etc.

To publish results of his investigations into compressor operation at elevated pressures in conjunction with cycling plant design, Ridgway presented a paper before the California Natural Gasoline Association in 1945, entitled, "The Effect of Supercompressibility of Natural Gas upon Compressor Performance," in which he showed how to calculate compressor capacity and horsepower wherever supercompressibility is involved. His methods have been widely used throughout the industry.

He is a member of CNGA and Tau Beta Pi.

Hobbies and Work Call for Fast Pace

PRESIDENT of Russell Engineering Corporation since its organization in July, 1950, George F. Russell, author of "Portable Low-Temperature Processing Equipment," on page 81 of this issue, has specialized in high-pressure natural gas processes since his university days when he received the American Gas Association Supplymen's fellowship in the graduate school at the University of Oklahoma.

He taught chemical engineering at Oklahoma and later was appointed associate professor of natural gas and petroleum engineering at L.S.U. Prior to entering the consulting work in 1948, he was associated with several operating and engineering companies, including Phillips Petroleum Company and Esso Standard Oil Company.

Avid fisherman and also an enthusiastic fan and armchair coach during Sooner football season, Russell continues his drive into the hobby of collecting phonograph records of European and American marching bands.

Panoma Gas Plant Designed by Them

PROCESS design of Panoma Corporation's gasoline plant near Hooker, Okla., described on page 71, was basically developed by **I. Earl Nutter.** He has been engaged in natural gasoline and related by-product manufacture since graduation from Oklahoma A. & M. in 1924. He joined Phillips Petroleum Company as plant chemist at Shidler, Okla., and later spent some time in the original organization of the Liquefied Petroleum Gas and, then the Research Departments. Progressive promotions made him chief technologist and assistant superintendent of the Texas Panhandle Division of Phillips natural gasoline department at Borger, Texas. In 1937 he joined the firm of Hagy, Harrington & Marsh, which later incorporated as Panoma Corporation.

Experience and Research

Numerous advanced features incorporated in Panoma's Hooker plant is a product of Nutter's years of experience and extensive research work.

Nutter has been a NGAA director for several years and is a member of API and IPAA.

Engineering design of Panoma's Hooker plant was directed by **C. D. Van Vliet** who has been engaged in engineering design of natural gasoline plants and refineries since his graduation from Iowa State College in 1938. He joined Phillips' engineering division Refinery Department, Bartlesville office, and later worked in the Borger refinery. In 1941 he joined The Fluor Corporation and worked in the Engineering Department at Kansas City and Philadelphia. In 1945 he joined the firm of Hagy, Harrington & Marsh, now Panoma Corporation.

The neat, orderly plant layout is attributed to Van Vliet's efforts, as well as the numerous advanced features of refinement to afford protection to equipment from the elements during extreme weather conditions. He assisted Nutter in seeking out advanced features of process design and in their application.

Turbine Operation

INSTALLATION, Operation and Maintenance of Mechanical Drive Steam Turbines," on page 104 is the work of William B. Yard, for the past eight years manager of the mechanical drive turbine division of Elliott Company's plant, Jeanette, Penn. Yard was graduated from Cornell University in 1929 with an electrical engineering degree. He immediately joined Elliott and has been there ever since.

Yard is interested in photography, his favorite subjects being his wife and two sons. He was president last year of the Toastmasters' Club in Greensburg, Penn.

On Tank Foundations

THE author of "Oil Storage Tank Foundations," page 125, is I. E. Boberg, associated with Chicago Bridge & Iron Company since 1924 graduation from the University of Illinois with a B.S. in civil engineering.

In 1935 he was appointed assistant to the chief engineer, which position he held until 1941 when he was given charge of the company's dry-dock building operations at Morgan City, La.

Upon returning to the Chicago home office in 1945, Boberg was made chief engineer in which capacity he has continued since.

The MONTH... in the INDUSTRY

Refinery now on stream at Bahia, Brazil

Bahia Refinery Provides Brazil with a "First"

A new refinery (pictured above)—the first to produce cracked gasoline in Brazil—has just recently been placed on stream at Bahia for Refinaria Nacional de Petroleo, S. A., by The M. W. Kellogg Company, New York.

A complete combination crude distillation and thermal cracking plant, the refinery is capable of processing 2500 barrels of crude daily. It is the first of its kind to be built in Brazil and, according to Kellogg, represents the most modern type of thermal combination processing.

Operating off one control room, the refinery employs a minimum of intermediate storage tanks and processing vessels. It "combines low investment cost and reduced operating expense with the production of high quality thermally cracked gasoline and other petroleum products."

Boron Compound Decreases Octane Demands of Motor

Experiments with a Boron compound added to motor gasoline containing tetraethyl lead show that the Boron additive prevents normal increase in octane requirements of an automobile engine as deposits built up, according to a paper presented to the American Chemical Society by Dr. E. C. Hughes, Ohio Standard research director.

Ethyl Corporation will make exhaustive tests of Boron additive under actual operating conditions. Dr. Hughes said additive is effective only in new engines or engines which have been cleaned, and only when the use of Boron-treated fuel is continuous. He claimed dirty engines are neither benefited nor harmed by Boron additive.

TEL Production Record Set But PAD Still Anxious

An all-time-high production record of tetraethyl lead is predicted for March according to a report issued by the Ethyl Corporation on the basis of current performance.

The report stated that Ethyl Corporation foresees no possibility of a shortage of raw materials and that production is scheduled to remain at capacity levels throughout the year. "An adequate supply of metallic sodium, ethyl chloride, ethylene dichloride and ethylene dibromide to maintain maximum production rate is assured by Ethyl's own plants for these materials," continued the statement by E. L. Shea, president of the company.

"Contracts for necessary tonnage of metallic lead also equal Ethyl's capacity production rate and no reason for suppliers to fail to meet contract requirements is anticipated," Shea said.

PAD however, anticipates a shortage of some materials and is urging NPA to divert metallic sodium, ethyl chloride and metallic lead to TEL manufacture at the expense of less essential uses. It feels threatened shortages menace the TEL stockpiling program as well as new TEL facilities due to be completed in 1952.

Iranian Oil Nationalized

Unanimous approval to a bill proposing nationalization of Iranian oil industry has been given by both houses of that country's parliament. Effect of the action, it was said, is to take the oil industry out of British-controlled Anglo-Iranian Oil Company control and to bar reconsideration by Iran's parliament or intervention by the International Court.

Alexander Fraser Retires

Alexander Fraser, chairman of the executive committee and a director of Shell Oil Company retired in March after 32 years service with that organization. Fraser is a past president of the Twenty-Five Year Club of the Oil Industry, a director of and was president of the Shell Oil Company from 1933 to 1949. Native to Glasgow, Scotland, Fraser received his earliest experience in shale oil enterprises in Scotland. In 1910 General Asphalt Company sent him to Trinidad oil fields, and, from there he as transferred to Philadelphia to supervise operations in both Trinidad and Venezuela. He joined Shell Oil Company in 1910 after serving as Secretary of the Inter-Allied Petroleum Council with headquarters in London, during World War I.

Fraser

Research Method Appears Favored by ASTM Group

American Society for Testing Materials Committee D-2 on Petroleum Products and Lubricants is considering a proposal for discontinuance of the use of Motor Octane Numbers (ASTM D 357, Method of Test for Knock Characteristics of Motor Fuels by the Motor Method) in the ASTM specifications for motor gasoline (ASTM D 439, Tentative Specifications for Gasoline) and substituting therefor the Research octane number (ASTM D 908, Method of Test for Knock Characteristics of Motor Fuels by the Research Method).

The proposal arises from the fact that many hold that Research octane numbers are more significant than Motor. Committee D-2 is keenly conscious of the limitations of both methods, it was said, "and will recommend the use of that method which most nearly meets the needs of those interested."

The Motor method (D 357) has been used in ASTM specifications for (motor) gasoline (D 439) since 1937. The Research method (D 908) was adopted as tentative in 1947. Since that time, there has been a definite trend toward more use of the Research method.

Opinions of consumers and producers of motor fuels should be addressed to W. T. Gunn, Secretary, ASTM Committee D-2, Room 2040, 50 West 50th Street, New York 20.

Canadian Oil Cooperates In Allocation Crisis

Assistant directors to the four sections of the newly established Petroleum Division, Department of Trade and Commerce (Canada), have been announced by director Dr. O. B. Hopkins, on loan from Imperial Oil.

Those named and divisions they will head are: refining, D. M. Morrison, Montreal, Shell Oil; producing, Ralph F. Will, Calgary, Calmont Oils; material, Harold E. Saunders, Montreal, McColl-Frontenac; supply and transportation, G. S. Hanna Toronto, British American.

In addition, Walker L. Taylor of Toronto (Imperial Oil) was named eastern representative of the producing section. The division was organized to insure that Canada's petroleum industry would share in allocations of materials in short supply, according to Dr. Hopkins.

PAD Holds April Meetings To Discuss Mobilization

Across-the-country field meetings were given first-half April schedules by PAD so that top officials might acquaint

SERVICE LEDGER
1907-1951

- ANGLO-IRANIAN OIL CO. LTD.
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- GLOBE OIL & REFINING CO.
- GULF OIL CORP.
- HUMBLE OIL & REFINING CO.
- IMPERIAL CHEMICAL INDUSTRIES
- IMPERIAL OIL LTD.
- KANOTEX REFINING CO.
- KENDALL REFINING CO.
- LEVER BROS.
- LION OIL CO.
- MAGNOLIA PETROLEUM CO.
- MARINE OIL REFINERS OF AFRICA, LTD.
- MATHIESON CHEMICAL CORP.
- McCOLL-FRONTENAC OIL CO., LTD.
- MID-CONTINENT PETROLEUM CORP.
- MITSUBISHI OIL CO., LTD.
- NATIONAL PETROLEUM COUNCIL OF BRAZIL
- PAN AMERICAN REFINING CORP.
- PENNZOIL CO.
- PHILLIPS PETROLEUM CO.
- POLYMER CORP., LTD.
- PURE OIL CO.
- SHELL CHEMICAL CORP.
- SHELL OIL CO.
- SHERWIN-WILLIAMS CO.
- SINCLAIR REFINING CO.
- SKELLY OIL CO.
- SOCIETE DES RAFFINERIES DE PETROLE DE LA GIRONDE
- SOCIETE GENERALE DES HUILES DE PETROLE
- SOCIETE INDUSTRIELLE BELGE DES PETROLES
- SOCONY-VACUUM FRANCAISE
- SOCONY-VACUUM OIL CO.
- E. R. SQUIBB & SONS
- STANDARD OIL CO. (INDIANA)
- STANDARD OIL CO. (OHIO)
- STANDARD OIL CO. OF CALIFORNIA
- SWIFT AND CO.
- TEXAS CO.
- UNION OIL CO. OF CALIFORNIA
- UTAH OIL REFINING CO.
- WASATCH OIL CO.
- WOOD RIVER OIL & REFINING CO.

Seven Mighty Crackers...for Texaco!

When The Texas Company built its first Fluid catalytic cracking unit back in 1942, Kellogg did the job. Since that time, Kellogg has erected seven additional crackers for Texas refineries in New Jersey, Illinois, Oklahoma, Wyoming, Texas and California.

Historically, Kellogg undertook its first job for Texaco back in 1929...a thermal cracker at Amarillo, Texas. During World War II, Kellogg designed a Hydroforming unit for the production of high octane components for aviation gasoline. Built at Lockport, Illinois, it was the forerunner of Texaco's vast post-war modernization and expansion program.

Within the past year, Kellogg has completed thermal reforming and catalytic polymerization facilities, as well as a catalytic cracker at Texaco's new refinery, Eagle Point Works, at Westville, New Jersey.

THE M. W. KELLOGG COMPANY
A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

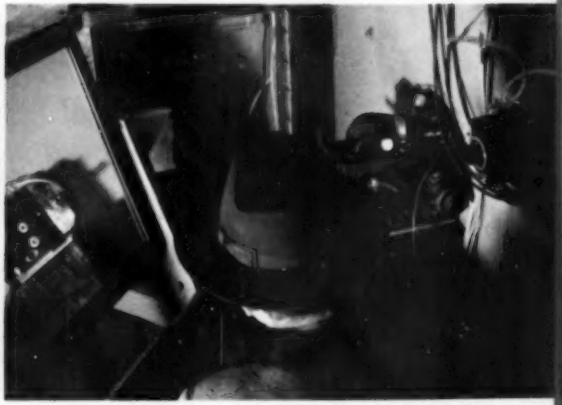
"Against Tomorrow's Conditions"

The first two of these camera "portraits" of M. W. Kellogg today which have already appeared in this publication, high-lighted the major aspects of the chemical, metallurgical and process research carried on by the Kellogg organization.

This month, a few of the continuing development projects based on this research are described —with indications of their importance in the advancement of processing, engineering and fabrication.

1. *WHILE THE PRIMARY ACTIVITY* of the Metallurgical Engineering group is concerned with the everyday problems of Kellogg operations, these facilities have also been utilized in connection with national defense. Because of their knowledge of metals and heat exchange, the services of these men have been required in the design of rockets and jet turbines. Here you see the engineering personnel assigned to this task.

4. *IN GAS AND ELECTRIC FURNACES* such as this, metals are subjected to temperatures approaching those of rocket engines in operation . . . and useful data from post-heat conditions of the materials can then be derived. Evidence of the success of Kellogg's work in these fields is seen in the fact that this development group has recently perfected a new method of heat exchange jacketing for combustion chambers.



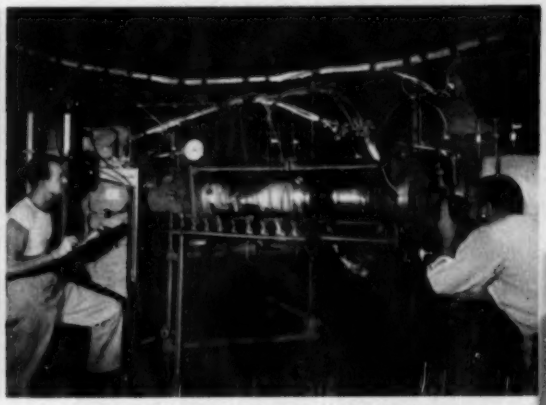
5. *KNOWLEDGE OF THE MECHANISM* of combustion of various fuels is as essential to the design of familiar process furnaces as it is to special combustion chambers. Here you see a test chamber for rocket and jet fuel study. In the future, such studies will stand industry in good stead as process plants are required to produce special jet and rocket fuels in quantity.

Fifty... no. 3

M KELLOGG W
1901-1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit. The forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 3 in the series.

2. ***AT FIRST GLANCE*** these specialized projects may appear far removed from the direct interest of the oil refiner. But the facts are just the reverse. The solution of rocket and jet turbine design problems opens new ranges of operating temperatures, new types of heat exchange equipment and tremendously improved turbines and pumps. Modern dynamometers are employed in studies of various types of turbines and pumps.



3. ***IN THIS MINIATURE TEMPERATURE CHAMBER,*** stratospheric frigidity can be created outside of a piece of equipment while it operates at super temperatures inside, or vice versa. This is a modern counterpart of the development which Kellogg instituted more than twenty years ago, when it began investigating the effect of low temperatures on metals in connection with propane lubricating oil processes.

6. ***AN IMPORTANT PHASE*** of the study of fuels is the observation and recording of the act of combustion itself—which is carried out by this apparatus—by means of high-speed color photography of flame characteristics and fuel burning. Other facilities include stands and firing pits for the testing of completed prototype rocket motors. The group has designed and built rocket motors with thrusts up to 30,000 lbs.

7. ***THESE ELECTRONIC SIMULATORS*** are indicative of the equipment placed at the disposal of the company's development men. Similar in purpose to the giant electronic calculating machines, they provide shortcut answers to design problems requiring extensive time-consuming mathematical calculation.

NEXT MONTH

. . . in the fourth in this series of camera studies of M. W. Kellogg today . . . you will see how Kellogg channels the results of development into a specific industrial project.

Special Treatment to Make a Tube Stand Up!

M. W. KELLOGG

Be it for high pressure or high vacuum . . . 1800F. or –260F. . . . corrosive or erosive service, exclusive manufacturing techniques lengthen the operating life of Kellogg heat exchange equipment.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

Continuing Basic Study of heat exchange by Kellogg development groups over 20 years has produced unduplicated design data.

Shop Layout Craftsmen have had experience on all types of heat exchangers, from marine condensers to jet engine combustion-chambers.

Rigid Quality Control is maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives.

Extensive Shop Facilities, from plate bending to stud threading, permit *complete* fabrication of any type heat exchanger.

Special Shop Techniques—the component parts of each exchanger are fabricated as a production unit, building in the advantages of "tailor-made" fit.

NEWS FOR OPERATORS IN WESTERN CANADA!

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at [illegible], Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

industrial men with oil mobilization activities and problems. Refining company presidents have received invitations to attend along with heads of their sales, manufacturing, purchasing and other departments. Marketing and refining associations were also invited to send representatives. Meetings were slated April 9, Shamrock Hotel, Houston; April 10, Biltmore Hotel, Los Angeles; April 11, Brown Palace, Denver; April 12, Stevens Hotel, Chicago; and April 13, Hotel Commodore, New York.

PAD officials participating include: A. P. Frame, assistant deputy administrator for domestic operations; Frank Watts, director of materials; W. P. Hayes, assistant director of supply and transportation; Reid Brazell, director of refining; Bryant Putney, director of public information, and also Colonel W. J. Worcester, Munitions Board Petroleum Committee.

Sulphuric Acid Shortage Necessitates Allocation

The Petroleum Administration for Defense is currently trying to determine how much sulphuric acid is needed in the petroleum refining industry. General industrial use of sulphuric acid must be curtailed because of a serious shortage of sulphur and Bruce K. Brown, PAD deputy, said the nation's supply is already 15 percent below requirements. The petroleum industry consumed more than 12 percent of total U. S. consumption in 1950.

Requests for data on individual uses of sulphuric acid have been made so that the information may enable PAD, as claimant agent for the petroleum industry, to determine over-all industry requirements.

The industry is also being asked how much sulphur could be recovered from spent acid sludges and from refinery and field gas streams, and whether individual refiners are operating or are considering the installation of facilities for recovery of sulphur from petroleum gases.

Duty and Peters Appointed Pan-Am Southern Company

Pan-Am Southern Corporation has named Lyle R. Duty assistant to the executive vice president, and Carl W. Peters as manager of economics. Peters will be responsible for company economic studies.

Duty was with Standard Oil Company (Indiana) for 22 years before joining Pan-Am Southern. His last assignment was as special representative of the comptroller.

At Princeton University in 1942, Peters was in charge of process economics and was engaged in economic studies of refinery operations and refinery planning. He too, transfers from the Standard Oil Company (Indiana) where he was employed in a supervisory and administrative position.

Pictorialized Lecture Offer

Making use of the "pictorialized lecture" technique, the Instrument Society of America has completed a 55 minute recording of "Principles of Automatic Control," in full color and sound, 16 mm.

Produced as one of the Society's educational projects, the recording is designed to be helpful in presenting the subject of automatic control to students, technical personnel, instrument mechanics, production supervisors and operators.

A leaflet, giving all details, can be obtained by writing the Instrument Society of America.

Physical Chemistry Award

Socony-Vacuum Oil Company, Inc., has awarded $2000 to Ohio State University, Columbus, Ohio, for continuation of a fellowship in physical chemistry during the period from April 1, 1951 to March 31, 1952.

A total of 20 fellowships will be supported by Socony-Vacuum during the 1951-52 academic year at colleges and universities throughout the country at a total cost of $40,000. It is a continuation of a program instituted several years ago.

THE OIL MAN'S CALENDAR

APRIL 10-12	Southwestern Gas Measurement Short Course, Norman, Okla., University of Oklahoma.
16-18	American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.
18-20	National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.
23-24	Industrial Accident Prevention Association, Annual Convention, Royal York Hotel, Toronto, Canada.
25-27	Natural Gasoline Association of America, Annual Meeting, Tulsa, Mayo Hotel.
30 to May 3	American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa, Mayo Hotel.
30 to May 3	American Petroleum Institute, Midyear; Safety and Fire Protection Committee, Tulsa, Mayo Hotel.
MAY 1- 3	American Oil Chemists' Society, Spring Meeting, New Orleans, Roosevelt Hotel.
7-10	Liquefied Petroleum Gas Association, Annual Meeting and Trade Show, Chicago, Stevens Hotel.
7-11	National Fire Protection Association, Annual, Detroit, Hotel Statler.
21-24	Oil Industry Information Committee, Denver, Brown Palace Hotel.
28 to June 6	Third World Petroleum Congress, The Hague-Scheveningen, Netherlands.
JUNE 7- 8	American Management Association, General Management Conference, New York, Waldorf-Astoria.
11-15	American Society of Mechanical Engineers, Semi-Annual, Toronto, Royal York Hotel.
14-15	Pennsylvania Grade Crude Oil Association, Annual Meeting, Pittsburgh, Hotel William Penn.
18-22	American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.
JULY 9-21	Summer Laboratory Course, "Techniques and Applications of the Electron Microscope," Laboratory of Electron Microscopy, Rockefeller Hall, Cornell University, Ithaca, N. Y.
SEPT. 10-14	Instrument Society of America, Sixth National Instrument Conference and Exhibit, Houston, Sam Houston Coliseum.
11-13	International Discussion on Postwar Heat Transfer Development with ASME Administrative Coordinator, London.
16-19	American Institute of Chemical Engineers, Regional Meeting, French Lick, Ind.
OCT. 14-20	Oil Progress Week.
15-18	American Gas Association, St. Louis.
NOV. 5- 8	American Petroleum Institute, Annual Convention, Chicago, Stevens Hotel.

The MONTH...

Corbett Joins Esso to Manage Belgium Plant

T. R. Corbett of Billings, Montana, has accepted the position of managing director for Esso Standard Refinery, S. A. of Belgium. The company is commencing the construction of a new refinery at Antwerp, Belgium, and is an affiliate of Standard Oil Company (New Jersey).

Corbett assumed his new duties this month and will take up residence in Antwerp about June 1. He has been manager of the manufacturing department for The Carter Oil Company since December, 1948.

William Gee Promoted By The Texas Company

William P. Gee, vice president of Texaco Development Corporation, has been promoted to assistant to the president of The Texas Company, it was announced today by Harry T. Klein, president of The Texas Company.

Born in Texas, Gee attended the University of Texas and Massachusetts Institute of Technology. He joined The Texas Company in 1927 as a research chemist in the Port Arthur, Texas, refinery. Actively engaged in the development and commercialization of many of the processes licensed by The Texas Company, Gee was working in the process licensing phases of Texaco Development Corporation.

Skelly Reorganizes Manufacturing Personnel

Skelly Oil Company has announced the reassignment of six of its manufacturing division personnel. G. E. Canaday was named manager of refineries and gasoline plants and will have general supervision of refineries, gasoline plants, lube and grease plants, the Pawhuska research laboratory and the gas contract and measurement department.

J. Y. Haslam, continuing as chief engineer of the manufacturing department, will assume responsibility for all construction work. He will head maintenance engineering in the refineries and gasoline plants and also engineering and construction pertaining to the gas gathering systems built by the manufacturing department.

H. H. Belew, special assistant to the vice president in charge of manufacturing and assistant to the manager of refineries, has charge of detailed matters pertaining to refining operations. He will be responsible for the manufacture of products in volumes consistent with sales forecast by the marketing department and will serve as chairman of the research coordinating committee. Pawhuska research laboratory will report directly to him on all matters concerning operation.

L. C. Newton is given charge of safety and personnel for the entire manufacturing department and will be directly interested in the refineries, lube and grease plants, and Pawhuska research laboratory.

G. D. Tidwell continues to supervise safety and personnel matters for the natural gasoline department and gas

The MONTH...

contract and measurement department. He will assume charge of automotive equipment and purchase of plant sites and rights-of-way for the manufacturing department.

John A. Craig, former chief engineer of gasoline and gas division, is assigned the duties of superintendent of gasoline plants.

WPRA Told Taxes Too High; Shortages Continue

Reduced octane ratings in the near future, continued shortage of raw materials for TEL production, and threat of restrictive and improper encroachments on the part of government were a few of the topics discussed in San Antonio when the Western Petroleum Refiners Association held its 39th annual meeting.

Reid Brazell, PAD director of refining division, warned that when allocation allotments of lead and other materials were gone, the refiners would find it useless to appeal to PAD. He observed that the octane number of automobile gas must be reduced by the refiner for his own survival. In confirmation of earlier fears expressed by PAD, Brazell informed the meeting that supplies of metallic sodium, ethyl chloride and pig lead are still in short supply that will continue through 1952.

Sharp warning to the petroleum industry was issued by R. W. McDowell, outgoing president of the association, who said that "certain" forces are trying to take advantage of the threat of war to lay restrictions and to make improper encroachments upon the industry. He said the industry was already carrying a greater share of the tax load than was just and that the industry must resist further taxation and restrictions.

McDowell will be succeeded by R. L. Tollett, Cosden Petroleum Corporation, Big Spring, Texas, 1951-52 president.

Announcement of a new motor fuel combustion process said to boost gasoline yield by 15 percent and to boost gasoline mileage by 30 percent was made by Blake Reynolds, Texaco Development Corporation. Laboratory results, he said, had proved successful on all types of gasoline, and if practical for production, the refiner in the future may concentrate on large yield instead of expensive low yield high octane fuels.

MEASUREMENT SOCIETY—An organization of oil and gas measurement men has passed the 140 membership mark and expects to enroll 250 members before the end of the year. Initially a group of ten under the leadership of Don Attaway, Arkansas Fuel Oil Company, they met in Shreveport, La., last December, adopted a constitution and named the organization Ark-La-Tex Measurement Society, with open membership to any person engaged in some phase of measurement in the oil and gas industry or manufacture and sale of measuring equipment.

Object of the society is to extend and disseminate measurement knowledge, combine and acquaint fellow workers, provide social and industrial contact whereby persons engaged in the profession may become more efficient in their jobs and better prepared for advancement, and to encourage the development of a high degree of recognition for the profession. Monthly meetings addressed by experts reveal surprisingly enough, according to the Society, that about 20 percent of those present see actual equipment and demonstrations for the first time.

J. P. Krouse, United Gas Pipeline Company, Shreveport, is president; Ralph Worley, The Parade Company, vice-president; Walter A. Stewart, Arkansas Natural Gas Corporation, treasurer; B. J. Caldwell, Texas Eastern Transmission Company, secretary. Twenty-six firms and supply companies are represented in the membership. The tri-state group hopes to establish a national organization with local chapters in every section of the country.

API Division of Refining Program

Another wide range of timely topics pertinent to the processing industry, are scheduled to be given at the 16th midyear meeting of the American Petroleum Institute's Division of Refining scheduled to be held April 30 to May 3 in the Mayo Hotel, Tulsa.

MONDAY, APRIL 30

9:00 a.m.—Analytical Research

Presiding: E. L. Baldeschwieler, Standard Oil Development Company, Linden, N. J.

"The Quenched Electrode Procedure in Spectrographic Analysis" (A report of the subcommittee on Emission Spectroscopy), H. O. Clark, Gulf Research & Development Company, Pittsburgh; "Characteristics of the Spectrographic Arc Emission of Metal Contaminants in Cracking Catalysts," E. L. Gunn, Humble Oil & Refining Company, Baytown, Texas; "Spectroscopic Determination of Vanadium in Residual Fuel Oils," J. W. Anderson and H. K. Hughes, Socony-Vacuum Laboratories, Brooklyn, N. Y.; "Determination of Iron in Used Lubricating Oils by Spectrochemical Analysis," J. Hansen, P. Skiba and C. R. Hodgkins, Standard Oil Development Company, Linden, N. J.

"Spectrographic Analysis of New and Used Lubricating Oils," C. M. Gambrill, A. G. Gassman and W. B. O'Neill, Ethyl Corporation, Detroit; "Testing Used Lubricating Oils for Normal Pentane and Benzene Insolubles," J. S. Wiberley, R. K. Siegfriedt and L. J. DiPaola, Socony-Vacuum Laboratories, Brooklyn; "The Determination of Benzene in the Presence of Olefines by Ultraviolet Spectrophotometry," J. A. Favre, R. C. Shank and B. J. Heinrich, Phillips Petroleum Company, Bartlesville, Okla.; "An Ultraviolet Method for the Determination of Total Alkyl Benzenes in Selected Crude Fractions," John F. Kinder, Sinclair Refining Company, Harvey, Ill.

2:00 p.m.—Analytical Research (Continued)

Presiding: C. E. Headington, The Atlantic Refining Company, Philadelphia.

"Safety Minute Man—Safe Laboratory Practices," J. H. Myer, The Atlantic Refining Company, Philadelphia; "Direct Determination of Oxygen in Organic Compounds by an Unterzaucher-Manometric Method," Joseph Holowchak and G. E. C. Wear, Standard Oil Development Company, Linden N. J.; "Determination of Oxygen in Organic Material," Morris Dundy and Ervin Stehr, The Texas Company, Beacon, New York; "The Polarographic Determination of Dissolved Oxygen in Petroleum Fractions," Maynard E. Hall, Humble Oil & Refining Company, Baytown, Texas.

"The Determination of Oil in Refinery Waste Waters—A Benzene Extraction—Semi-Micro Method," A. F. S. Musante, Sun Oil Company, Marcus Hook, Pa.; "Infrared Spectrophotometric Determination of Oils and Phenols in Water," R. G. Simard, I. Hasegawa, W. Bandaruk, and C. E. Headington, The Atlantic Refining Company, Philadelphia; "The Infrared Spectra and Structures of Paraffins, Olefins and Alkyl Aromatics," H. L. McCurry and Vernon Thornton, Phillips Petroleum Company, Bartlesville, Okla.; "Modern Analytical Distillation of Crude Petroleum," J. A. Lockwood, R. L. Letourneau, Robert Matteson and Frank Sipos, California Research Corporation, Richmond, Calif.

TUESDAY, MAY 1

9:00 a.m.—Refinery Waste Water

Presiding: G. A. Davidson, Standard Oil Company of California, San Francisco.

"Chemical Treating Plant for Refinery Waste Water," Hans Schindler, L. Sonneborn & Sons,

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
Trends in Week Ended	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1950:									
January 20	4,956	5,470	248,411	18,363	124,270	7,302	66,327	9,330	57,036
February 25	5,000	5,277	245,586	17,703	133,888	6,890	56,058	7,855	48,663
March 25	4,848	5,460	244,227	17,830	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,658	6,531	36,686	7,272	39,260
May 27	5,118	5,591	240,842	18,704	122,757	7,201	40,607	7,421	39,306
June 24	5,355	5,656	240,762	19,626	115,026	6,958	50,580	7,461	41,291
July 29	5,522	5,670	240,236	19,981	109,076	7,266	61,437	7,870	42,253
August 26	5,699	6,197	236,934	20,263	105,793	7,550	65,841	8,543	41,597
September 30	5,903	6,051	241,631	19,624	104,383	8,460	76,734	8,366	42,330
October 28	5,896	6,051	244,805	19,878	105,062	8,250	84,057	8,449	44,310
November 25	5,888	6,238	244,497	19,847	106,424	8,591	86,798	8,470	45,566
December 23	5,763	6,159	250,709	20,075	112,631	9,436	73,373	8,715	39,914
1951:									
January 27	6,066	6,482	244,230	21,106	126,261	9,954	58,987	9,905	40,378
February 24	5,854	6,524	237,204	20,815	136,870	10,545	48,784	9,471	38,995
March 31	6,041	6,381	*232,532	20,398	142,186	9,365	43,170	9,147	37,282

* March 24 Stocks.

These tubes go in to stay!

Thanks to CHASE ANTIMONIAL ADMIRALTY

(a patented alloy)

Here's the reason Chase Antimonial Admiralty* keeps heat exchanger tubes on the job year after year:

They've got *enough* antimony to resist dezincification. And antimony will not affect the metal's grain structure and won't weaken the tube.

When you get Chase Antimonial Admiralty Condenser Tubes, you're getting metal that *stays tough* . . . stands up under heavy stresses . . . lasts for years.

Years of use have proved Chase Antimonial Admiralty's superiority!

*U. S. Pat. No. 2,061,921

Special stocks of
ANTIMONIAL ADMIRALTY
Condenser Tubes in Chase Warehouses:
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LOS ANGELES
also carried by—
Vinson Supply Co., Tulsa
Standard Brass & Mfg. Co., Houston

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Boston	Detroit	Minneapolis	Providence	
Chicago	Hartford†	Newark	Rochester†	(†Sales office only)
Cincinnati	Indianapolis	New Orleans	St. Louis	

The four meters illustrated are part of a total installation of nine R-C Meters in a large processing plant. These units measure acetylene gas sold to nearby manufacturers, who also use R-C Meters at the receiving ends. Capacities range from 3,000 cfh to 130,000 cfh.

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The MONTH . . .

Petrolia, Pa.; "Dissolved Air Flotation Separates Oil from Waste Waters," Nicholas D'Arcy, Jr., Huntington Park, Calif.; "The Fundamentals and Performance of Gravity Separators—A Literature Survey," Alfred C. Ingersoll, California Institute of Technology, Pasadena, Calif.; "Hydraulic Characteristics of Gravity Type Oil-Water Separators," Gerald A. Rohlich, University of Wisconsin, Madison, Wis.; Film—"The Behavior of Oil-Water Mixtures in Gravity Separators—The Photographic Record of Oil-Water Separation Research," (Prepared by the Hydraulics Laboratory, University of Wisconsin, Madison, Wis.; "Safety Minute Man: Safety in Handling Wastes," D. L. Rankin, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

2:00 p.m.—Corrosion

Presiding: W. H. Creel, Phillips Petroleum Company, Bartlesville, Okla.

"Use of Aluminum in Refinery Equipment," W. E. Baker and E. E. Kerns, The Standard Oil Company (Ohio), Cleveland, Ohio; "Corrosion-Prevention Program for a TCC Unit Gas Plant," C. A. Murray and M. A. Furth, The Pure Oil Company, Smiths Bluff, Texas; "Hydrogen Attack of Steel in Refinery Equipment," J. G. Wilson, R. T. Effinger, M. L. Renquist and A. Wachter, Shell Oil Company, New York; "Safety Minute Man: Corrosion Hazards," J. H. DeLaune, Cities Service Refining Corporation, Lake Charles, La.

WEDNESDAY, MAY 2

10:00 a.m.—Electrical Equipment

Presiding: L. M. Goldsmith, The Atlantic Refining Company, Philadelphia.

"Explosion Proof Motor Control and Twitchgear," B. M. Mills, General Electric Company, Schenectady, N. Y.; "Explosion Proof Motor Design and Application to the Petroleum Industry," J. E. Linsenmeyer and C. R. Olsen, Westinghouse Electric Corporation, East Pittsburgh; "Safety Minute Man: Electrical Hazards," Henry W. Boggess, Sinclair Oil & Gas Company, Tulsa.

2:00 p.m.—Training Technical Men

Presiding: Harold G. Osborn, Continental Oil Company, Ponca City, Okla.

"Indoctrination Programs for Technical Personnel," F. C. Cutting, Shell Oil Company, New York; "Industry Practice in Training Technical Personnel," H. G. Vesper and D. H. Etzler, California Research Corporation, San Francisco; "Technical Classrooms on the Job," H. D. Wilde, Humble Oil & Refining Company, Houston; "Safety Minute Man: Safety—A Part of the Technical Man's Training," L. A. Martin, Oklahoma A. & M. College, Stillwater.

7:00 p.m.—Open Dinner

Presiding: W. L. Stewart, Jr., API vice president for refining.

Address: Mr. Stewart.

Address: "The Lost Art of Laziness," Stewart Harral, Director of Public Relations, University of Oklahoma, Norman.

THURSDAY, MAY 3

10:00 a.m.—Fuel Utilization

Presiding: C. E. Davis, Shell Oil Company, New York.

"Economic Relationship of Engine-Fuel Research," C. L. McCuen, General Motors Corporation, Detroit.

1:30 p.m.—LPG As Motor Fuel

Presiding: Ross W. Thomas, Phillips Petroleum Company, Bartlesville, Okla.

"LP-Gas, Over a Million Barrels Daily," R. C. Alden, Forrest E. Gilmore and Paul Tucker, Phillips Petroleum Company, Bartlesville; "The LP-Gas Industry's Progress in Meeting Its Distribution Challenge to Old and New Markets," Howard E. Felt, Warren Petroleum Company, Tulsa; "The Use of LP-Gas as Tractor Fuel," Ernest Fannin, Fannin's Gas and Equipment Company, Phoenix, Ariz.; "The Propane Story," Robert S. Lee, Twin Coach Company, Kent, Ohio; "The Relative Economics of LPG, Gasoline, and Diesel Fuel in Trucks and Buses," Eugene S. Corner, Standard Oil Development Company and E. H. Berg, Esso Standard Oil Company, New York.

Bath Joins Battenfeld As Chief Lube Engineer

T. Nicholas Bath has been named chief lubrication engineer for the Battenfeld Grease & Oil Corporation, Kansas City, Mo. Bath graduated from the University of Illinois in 1929 with a degree in Chemical Engineering, then served as a chemist for the Pennsylvania Petroleum Company and the Kansas City Testing Laboratories before joining Shell Oil Company in 1935. When he left Shell Oil in 1950, he was assist-

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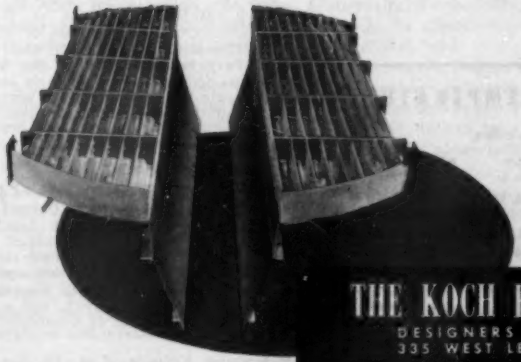

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The MONTH...

ant manager of the lubrication department in charge of nation-wide industrial lubrication sales.

Pines Appointed to Teach

Dr. Herman Pines, a research coordinator with Universal Oil Products Company, Chicago, has been appointed associate professor of chemistry at Northwestern University. Dr. Pines is also associate director of the Ipatieff High Pressure Catalytic Laboratory at Northwestern, where he has served since 1941.

Pines

Dr. Pines, who joined Universal in 1930, has authored about 75 scientific papers and holds 90 patents in connection with the manufacture of gasoline and various chemicals from petroleum.

Dr. Pines was granted his Chemical Engineering degree from the Institute of Chemistry, University of Lyon, France, and his Ph.D. from the University of Chicago.

E. Holley Poe Dies

E. Holley Poe, who formed the Texas Eastern Transmission Corporation and was a prominent figure in the gas industry, died last month.

In 1936 Poe became manager of Oklahoma properties of the Central States Power and Light Corporation, later was named secretary of the natural gas department of the American Gas Association and during World War II served as director of the Natural Gas and Natural Gasoline Division of PAW.

Poe formed a consulting firm, E. Holley Poe and Associates, with offices in New York, Washington, and Chicago; was president and treasurer of American Gas Journal, director of Texas Eastern Transmission Corporation, vice president of Atlantic Venezuela Transmission Corporation, the United States Pipe Line Company, chairman of the board of North American Petroleum Gas Corporation, and held other positions and interests.

Max B. Miller Dies

Max B. Miller, owner-president of Max B. Miller Corporation of New York as well as the president of Milwhite Company of Houston, died in New York late last month. He had served as federal co-ordinator on steel in the petroleum industry for several years and was well-known to the oil industry.

Arthur Sherwood Dies

Arthur H. Sherwood, 70, Eastern district sales manager for Petro-Chem Development Company, died in Garden City, Long Island. A 1901 graduate of Cornell, all of "Sherry's" business years were identified with oil refining equipment: Wilson-Snyder Pump Corporation, U. S. Steel Corporation, and with Petro-Chem Development Company.

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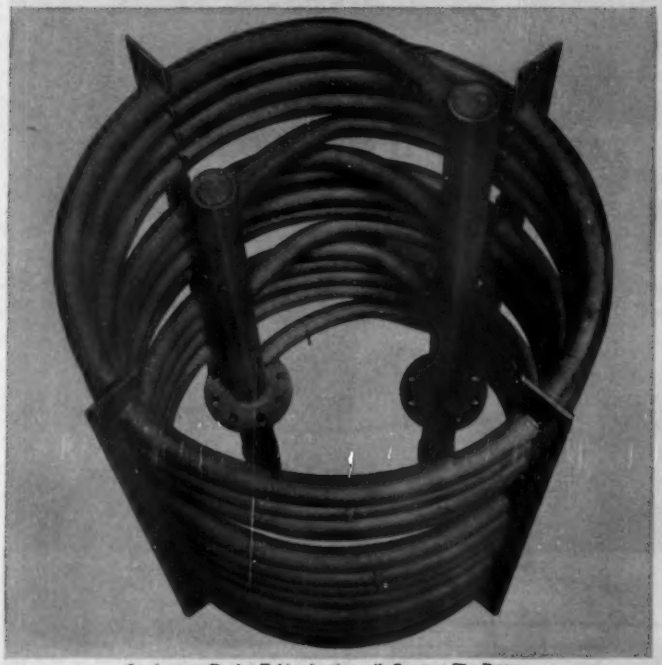
Lead-Copper Duplex Tubes
For Heating Sulphuric Acid Solutions



Lead-copper Duplex Tubing heating coil. Courtesy The Patterson-Kelley Company, Inc., East Stroudsburg, Pennsylvania.

One of the most corrosive liquids widely used in industrial processing is sulphuric acid in various concentrations. Aside from lead no other commercial metal can withstand sulphuric acid under a wide range of conditions for any appreciable length of time. This explains why containers for sulphuric acid solutions are usually lead-lined. Steam heating and cooling coils immersed in sulphuric acid solutions are also generally made from lead.

Lead-Copper Duplex Tubes

Installations of coils made from Duplex Tubing, lead outside with copper inside, have shown some important advantages over lead tubing. The stronger, harder inner tube of copper permits the use of higher steam temperatures and pressures than are practical with the softer and weaker lead tubing. Thus the usable range of temperature and pressure is increased substantially. Furthermore, copper withstands the effects of corrosive steam better than lead.

Lead-copper Duplex Tubing may be used at steam pressures up to 150 lbs. per square inch at 360°F, whereas lead tubing is limited to a maximum of about 50 lbs. steam pressure at 300°F.

Corrosion resistance of lead is generally excellent in sulphuric acid solutions containing up to 50% acid. Lead is also resistant to sulphurous, phosphoric and chromic acids, all of which can be heated or cooled by immersion of lead-copper Duplex heating coils. Lead is also satisfactory for resisting corrosion from wet or dry sulphur dioxide and sulphur trioxide.

The thickness of the lead component of lead-copper Duplex Tubing is usually ⅛" or more depending upon the severity of the requirements.

Duplex Tubing can be made of several grades of lead, to meet A. S. T. M. specifications. Through the use of high purity lead, maximum corrosion resistance can be obtained. The high purity leads (chemical) are useful up to about 400°F. Antimonial leads, because of their lower melting points, are limited to a maximum of about 250°F.

Joining Duplex Tubes

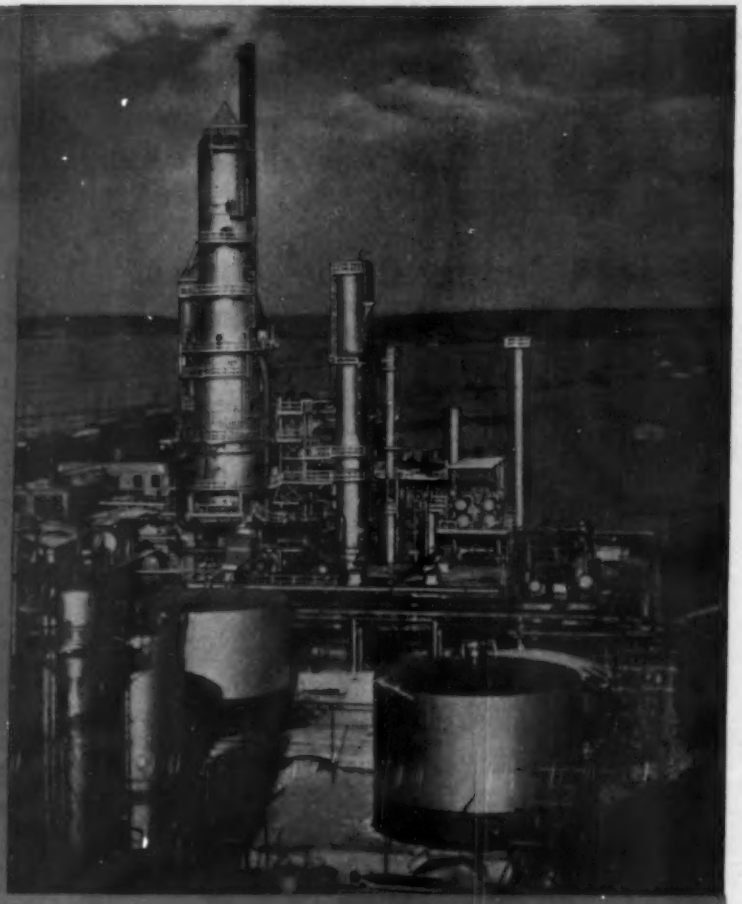
In making heating coils from Duplex Tubing, it may be necessary to join two or more lengths to obtain the required sizes of coils. Joints are made by cutting back the outer lead component about ½" from each end of the Duplex tubes to be connected. The copper inner tube from one end is expanded by driving in a plug of the proper size so that the expanded end becomes large enough to receive the copper inner tube of the other Duplex tube. The joint is secured by soldering. A thick overlay of lead is wiped on to cover the exposed copper.

After prolonged service, lead-copper Duplex Tubing coils possess excellent heating transfer characteristics and exhibit superior corrosion resistance.

Bridgeport Duplex Tube—lead outside and copper inside.

There are, of course, many other processing applications for lead-copper Duplex Tubing than for heating and cooling sulphuric acid. Information on various components of metals used in Duplex Tubing, as well as the variety of applications, are published in Bridgeport's "Duplex Tubing Technical Bulletin No. 1950", which will be mailed upon requests made on company stationery. (6542)

This modern Cat Cracker plant of Globe Oil and Refining is impressive evidence that



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Refinery and Other Plant Construction Notes

Petroleum Refiner's quarterly "boxscore" tabulation—

eight pages—starts on page 137

Cost of Tax Write-Offs Will Be High, Brown Warns

Government cost to grant all 396 oil project applications for fast tax amortization would run between $641 million to $1.05 billion according to a statement by Deputy PAD Bruce K. Brown, who testified before a House Appropriations Subcommittee considering grant of $51 million additional funds to run mobilization agencies for the rest of the 1951 fiscal year. Brown said the government revenue loss over a five-year period would be: $641 million if applicants on the average are subject only to normal tax and surtax (47 percent); $846 million if applicants on the average are subject to over-all limitations of 62 percent; and $1.05 billion if applicants on the average are subject to normal tax, surtax, and excess profits tax (77 percent).

The greater part of the fast tax amortizations approved for the oil industry by Defense Production Administration has been awarded refinery expansion projects, the biggest single authorization of more than $18 million going to Gulf Oil Corporation. According to DPA the average individual tax write-off on the basis of the 231 companies issued certificates amounted to 74 percent of total project costs, with percentage based generally on the relationship of the proposed expansion project to direct defense effort.

Projects certified for companies in oil and allied industries follow:

Rothschild Oil, Santa Fe Springs, Calif., Avgas components, $2,050,000.

Union Oil, Wilmington, Calif., gasoline components, $4,500,000; and $12 million additional for gasoline and fuel oil.

Fletcher Oil, Wilmington, Calif., gasoline and fuel oil, $176,250.

Wood River Oil Refining, Gary, Ind., gasoline and fuel oil, $7,686,000.

Levelland Refining, Levelland, Texas, Avgas, $2,441,763.

Bay Petroleum, Chalmette, La., gasoline components, $1,726,500.

Pan American Refining, Texas City, benzene, $1,100,000.

Gulf Oil Corporation, Port Arthur, Texas, isobutane for gasoline, $18,465,342.

Petco Corporation, Blue Island, Ill., gasoline and fuel oil, $1,936,000.

Derby Oil, Wichita, Kans., high octane gasoline and fuel oil, $2,206,041.

Phillips Petroleum, Borger, Texas, propane and butane, $4,056,575.

Ben Hur Refining, Long Beach, Calif., gasoline and fuel oil, $2,230,000.

Northwestern Refining, St. Paul, Minn., high-octane gasoline, $2,074,998.

Superior Refinery Owners, Inc., Superior, Wis., gasoline and fuel oil, $1,228,800.

Sunray Oil, Stephens County, Okla., gasoline components, $1,750,866.

Pan American Southern, New Orleans, gasoline, $5,500,000.

California Standard, El Segundo, benzene and gasoline, $14 million.

Atlas Processing, Shreveport, La., benzene, $2,600,000.

M. F. A. Oil, Memphis, gasoline, $1,720,000.

Aurora Gasoline & Keystone Oil, Detroit, diesel and industrial fuels, $3,970,000.

Sunland Refining, Bakersfield, Calif., gasoline and fuel oil, $501,653.

Western Oil & Fuel, near Duluth, Minn., gasoline and fuel oil, $5,992,000.

White Fuel Corporation, Boston, petroleum compounds, $175,000.

Tennessee Eastman Corporation, Longview, Texas, ethyl alcohol, $6,787,000.

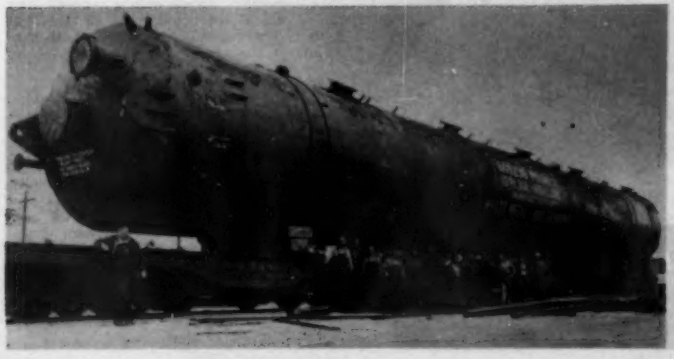
Ethyl Corporation, Baton Rouge, La., ($176,000), and Houston, ($44,136,000), antiknock compounds.

Sinclair Oil Corporation, Houston, butylene and petroleum, $27 million.

Dow Chemical Company, Freeport, Texas, ethylene and dibromide, $5,185,000.

Filtrol Corporation, Salt Lake City, pelleted catalytic cracking catalysts, $726,400.

49-TRAY DEPROPANIZER—This 49-tray depropanizer is "the heaviest single railroad shipment ever made from Houston, as well as the heaviest piece of petroleum refinery equipment ever shipped by rail anywhere." Thirteen feet, four inches in diameter by 120 feet long, and weighing 601,236 pounds, it was fabricated in the Houston plant of Wyatt Metal & Boiler Works. Two special built, heavy duty railroad cars were used to carry the load of more than 300 tons, the middle car serving as an idler to take care of trackage curves. For security, all bridges along the route were checked for clearance and strength.



Kellogg to Build African Synthetic Coal-Oil Plant

The M. W. Kellogg Company will in the near future build a commercial liquid-fuels-from-coal synthesis plant near the town of Coalbrook in the Orange Free State of South Africa. The South Africa Coal Oil and Gas Corporation, Ltd. has contracted for the plant which will constitute the first application of Kellogg Synthol process.

Kellogg process to be used in synthesis step will employ "a radically new type of reactor to handle powdered catalyst," and is also said to involve new fundamental operating conditions which improve both the economy and operability of the synthesizing process.

Designed primarily to produce gasoline and diesel fuel, the plant facilities will include high octane gasoline processes. Capacity has not been disclosed.

Pan-Am Southern Starts High-Octane Gas Expansion

Pan-Am Southern Corporation has awarded a $6.5 million contract to The Lummus Company for immediate expansion of its Destrehan, La., refinery. The expansion was approved by PAD which issued a certificate of necessity under the long-range governmental program to increase aviation gas and jet fuel production.

The present refinery consists of a crude unit which processes 8000 barrels of asphaltic crude a day, lube oil and grease blending facilities, terminal facilities, river docks and 3-million-barrel tankage.

Expansion plans call for production of 7500 barrels a day of aviation gas and 5000 barrels of jet fuel among other products.

After the crude unit is revamped it will permit simultaneous processing of 15,000 barrels a day of light coastal crude to low percentage fuel oil bottoms and 5000 barrels of heavy asphalt crude to asphalt bottoms. The catalytic cracking unit will process 12,000 barrels a day of gas oil at high conversion operating in block operation with a retreating cycle. Light ends from the fluid catalytic cracking unit will be recovered by the vapor recovery unit. Products from this unit will consist of PP-BB charge recovery unit designed that recovery of propylene can be varied from 60 volume percent to practically zero volume percent.

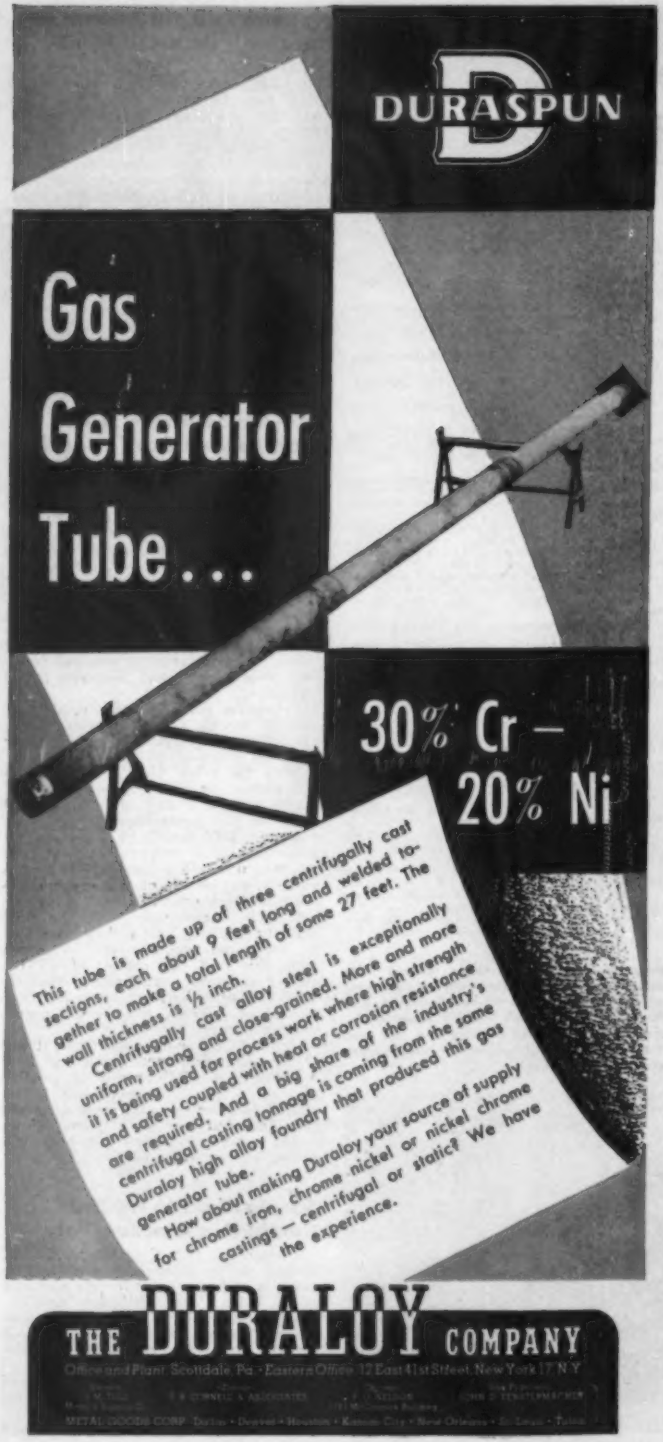
Sulfuric acid will be used as catalyst in the alkylation unit which will have a capacity of 2500 barrels of aviation alkylate a day. Flexibility will be installed to allow for alkylation of mixed propylene butylene or butylenes alone.

The company estimates the plant will go on stream July, 1952.

Sarnia Plant to Try Unit Combining Cracker, Poly

Canadian Oil Company's new 18 million dollar refinery at Sarnia, Ontario, is said to provide for the first unit of its kind, a new Orthoflow catalytic cracker operating in combination with catalytic polymerization. The plant will produce high-octane stock for both aviation and automotive gasoline. Gas oil feed for the cracker will be produced from 20,000 barrels a day of Alberta crude.

Canadian Kellogg Company, Ltd., will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begin construction of the plant this month and will design and erect a combination Fluid catalytic cracking and catalytic polymerization unit as well as special fractionating equipment to produce butane and propane. Plant is scheduled to go on stream in 1952.

Butylene production by the special fractionating equipment is to be consigned to the nearby government-owned Polymer Corporation's synthetic rubber plant. The refinery will be owned and operated by Canadian Oil Companies and Canadian Oil Refineries.

Cat Cracker Model IV to Be Built At Edmonton Plant

First of the new, greatly improved and simplified type of fluid catalytic cracking units, known as Model IV, will be built by Foster Wheeler, Ltd., at the Edmonton, Alberta, refinery of Imperial Oil Company. The catalytic cracking unit will have a capacity of 10,000 barrels per day, and over-all capacity will be further increased by the additional construction which includes a 10,000 barrel per day vacuum unit for feed preparation and a gas compression and gas fractionation plant.

The Model IV type catalytic cracking unit is the result of research and development by Standard Oil Development Company. New features thus developed were incorporated in the design and made possible an over-all simplification and rationalization of catalytic cracking units, as well as a substantial reduction in total cost.

The Model IV is small, close to the ground. Even the highest points of the two main vessels are less than 100 feet above ground on the 10,000-barrel-per-day unit being built for Imperial.

Imperial Oil Announces Sarnia Plant Expansion

Plans for major expansion and modernization of its Sarnia refinery have been announced by Imperial Oil Company, Ltd. of Canada. Included is the construction of a 46,000-barrels-a-day atmosphere and vacuum distillation unit, a 23,250-barrel-a-day Fluid catalytic cracking unit and a light ends recovery plant.

When construction is completed the capacity will have been raised to 71,000 barrels per day, a gain of 15,500 barrels daily. The atmosphere and vacuum unit will be the largest single refining unit in Canada, according to Dr. J. L. Huggett, general superintendent of the refinery.

Koa Oil Company Plans Refinery Expansion Units

Koa Oil Company, Ltd., Tokyo, plans this year to increase refined oil and crude storage capacity and to add facilities to produce lubricating oils. A 3000-barrel-per-day vacuum distillation unit and a 1000-barrel contact rerun unit under construction by Tatsumi Engineering Company are expected to be completed this summer. A solvent dewaxing plant and a solvent extracting plant are in design stage; probable completion date for all projects is scheduled for early 1952.

The Marifu refinery's 6000-barrel-per-

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day topping plant and 2500-barrel cracking plant are charging 3000 barrels daily of crude, the maximum allowable under government restriction. Allocation levels are expected to be raised this month however.

Expansion was made possible last November when Koa Oil Company negotiated a capital tie-up with Caltex Oil Products Company on a 50-50 basis. The company was founded in 1933 with a lubricating oil and grease unit at Yokahama. Marifu refinery was built in 1938 to give the company a modern crude plant. The topping plant was constructed in 1943; the 7500-barrel catalytic cracking plant installed in 1945 was destroyed by air raids. Refining operations ceased by military order from 1946 to 1949.

Koppers Will Increase Styrene Monomer Capacity

Koppers Company, Inc., has announced a multi-million dollar program of expansion for its Chemical Division which provides for construction of a new plant near Port Arthur, Texas, and additions to its present facilities at Kobuta, Pa.

The Texas plant, to be constructed by Koppers Engineering and Construction Division will take ethylene from the unit which Gulf Oil will build at Port Arthur and combine it with benzene to make ethyl-benzene. The ethyl-benzene will be transported to Kobuta, where it will be used in the production of styrene monomer. The Kobuta program will center around expansion of styrene monomer production facilities and additional storage space.

The new refinery at Port Arthur will be named "Williams" in honor of J. P. Williams, Jr., former president and chairman of Koppers, now retired.

Gulf's New Plant Records

Two new Gulf Oil Corporation natural gasoline plants at Waddell, Texas, and Eunice, New Mexico, the first major installations of the kind built by Gulf in recent years, produced 25,075,000 gallons of gasoline in 1950, according to a report issued by the company.

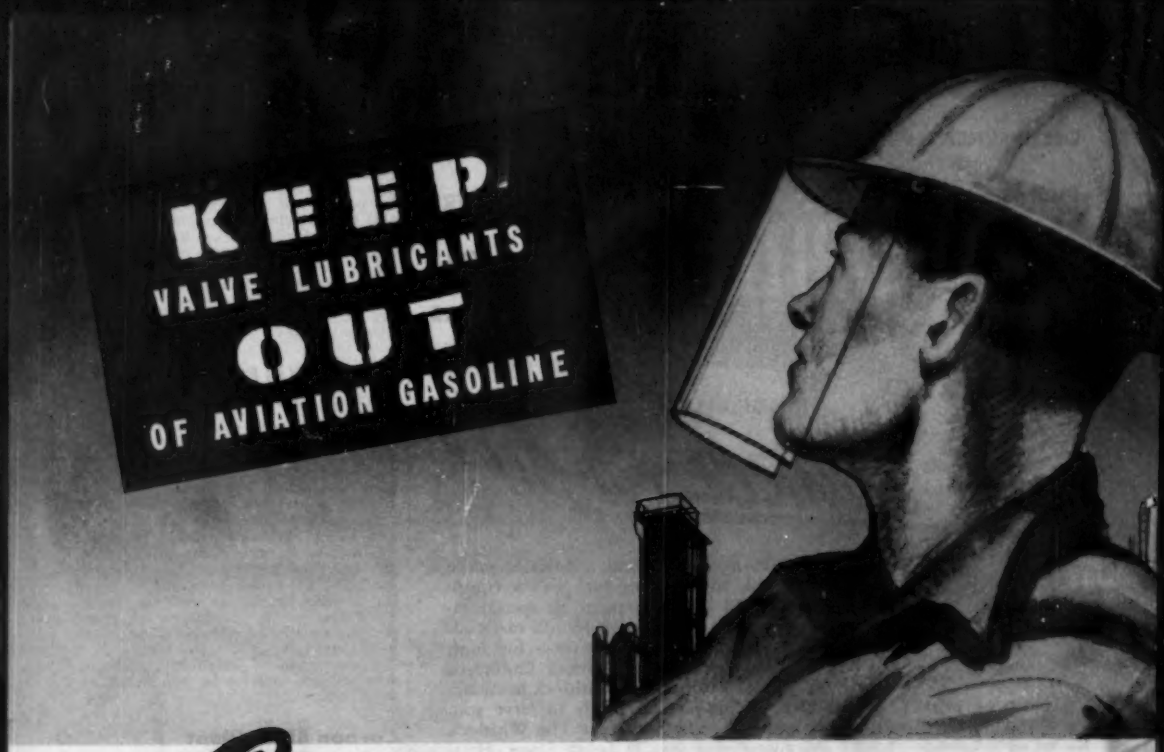
The multi-million dollar installations, in operation since the fall of 1949, also had a joint production of 25,310,000 gallons of propane, 11,015,000 gallons of butane, and 16,740,000,000 cubic feet of residue gas during 1950.

These facilities processed 27,458 million cubic feet of casinghead output last year.

Atlantic Plans Benzene Unit Near Philadelphia

The Atlantic Refining Company plans to build a new 11,000 barrel per day catalytic reforming unit at its Point Breeze refinery near Philadelphia at a cost of between $4 and $5 million. Construction is expected to begin soon with probable production in early 1952.

The reforming unit will upgrade straight-run gasoline, using a new process developed by the company. The company has been operating a five-barrel-per-day pilot plant at Philadelphia since last July to develop its idea. The metallic platinum catalyst developed by



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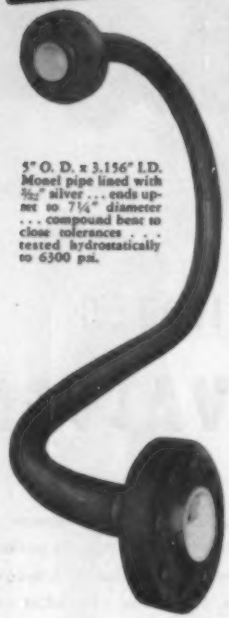

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Construction

The Atlantic Refining Company will be supplied by Davison Chemical Corporation, Baltimore.

Enough feed stock is presently available to the refinery, according to company estimates, to make 500 barrels per day of benzene, a rate of production which would keep the unit busy only 15 percent of the time. If sufficient feed stock were available, company engineers say output could be stepped up to 3000 barrels per day.

Phillips Will Expand Woods Cross Refinery

A catalytic cracker, vacuum plant facilities for feed stock preparation, added raw and finished product storage and handling facilities, and a new gas plant. are inclued in expansion plans for Phillips Petroleum Company's Woods Cross refinery near Salt Lake City. A new office building also will be built.

The new cracking plant will provide the heart of an appreciably enlarged operation producing high quality fuels for civilian needs, as well as being adaptable for the production of components used in blending aviation gasoline, President K. S. Adams said.

Construction is scheduled to begin this summer, and to be completed by July, 1952.

Carbon Black Plant Built at Shamrock, Texas

New furnace process facilities for production of furnace type carbon black is being built six miles east of Shamrock, Texas, by United Carbon Company, Inc., Charleston, W. Va., and will eventually have a capacity of 25 million pounds annually.

The carbon plant is said to cost in excess of $1.5 million and is scheduled to go in operation about May 1, producing gas base furnace blacks of the semi-reinforcing (SRF) and high modulus (HMF) types.

Cold Rubber Production Boosted at Port Neches

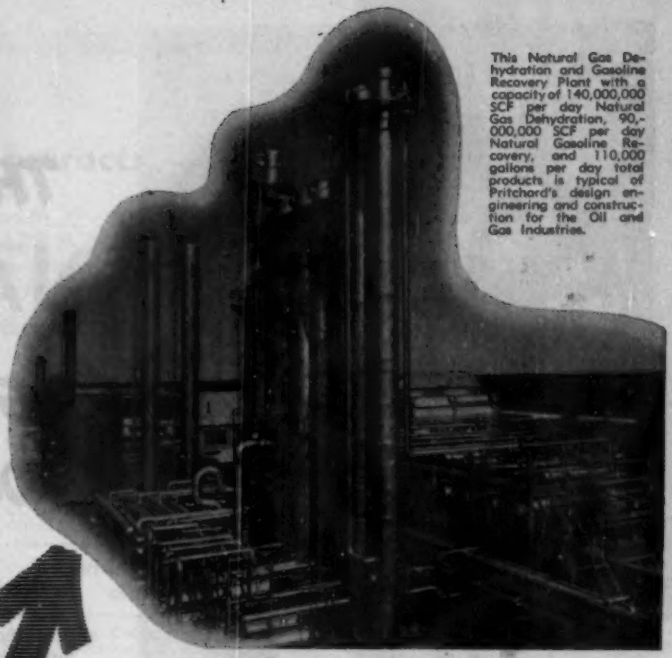
Production of cold rubber at the Port Neches, Texas, government plant operated by B. F. Goodrich Chemical Company will be increased 50 percent. Installation of refrigeration equipment costing $350,000 to expand cold rubber production from 30,000 to 45,000 tons of the plant's 60,000-ton annual rated capacity, has been authorized.

The Port Neches units are operating in excess of 135 percent of their rated capacity.

Helium Plant Reopened

The helium plant at Otis, Kansas, will be reopened to meet increasing military and industrial requirements according to James Boyd, Director of the Bureau of Mines. The Bureau mine which has a rated capacity of about 48 million cubic feet annually, will supplement the production of the helium plant at Exell, Texas.

Closed in 1945 and placed in stand-by condition, the Otis plant cost about $3.5 million when it was built early in World War II.



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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

View of Humble Oil & Refining Company's Baytown, Texas, refinery seen through window of Research Laboratory, recently opened.

Products: Properties, Utilization and Analysis

Low Temperature Separation of Ethane from Methane and Air. ROBERT L. SLOBOD. *Analytical Chem.*, **23** (1951), pp. 361-3.

In prospecting for oil by geochemical methods, gas samples containing methane, ethane and heavier hydrocarbons, along with air, are frequently obtained in which ethane and heavier hydrocarbon fractions must be determined. The author developed a method using liquid nitrogen at reduced pressure to separate the ethane quantitatively from methane and air. A special trap was designed incorporating a low temperature reservoir containing liquid nitrogen maintained at reduced pressure. This low temperature nitrogen bath cools a container of liquid nitrogen which for accessibility is open to the atmosphere. If liquid nitrogen at atmospheric pressure is used as the refrigerant, there is incomplete recovery of ethane from the gas phase. The use of nitrogen at reduced pressure results in complete recovery of ethane.

The Design and Operation of an Automatic 15-Litre Still. K. H. V. FRENCH AND L. W. BARNARD. *Jour. Soc. Chem. Ind.*, **69** (1950), Supp. Issue No. 2, pp. S-60-5.

The authors describe an all-metal fractionating column, having a charging capacity of 15 liters and suitable for fractionation material with a boiling range from 40° to 180° C. Automatic controls and safety devices are used so that fractionation may continue up to three days without an operator being present. The reflux ratio is automatically changed with the slope of the distillation curve, using a high ratio when the curve rises rapidly and a low ratio when the curve is flat. Fractions are automatically collected, and correspond to the various sections of the distillation curve, rather than to any fixed time interval. The equipment is described and shown diagrammatically in some detail, and typical operating results are presented.

Determination of the Ring and Ball Softening Point of Asphaltic Bitumens with and without Stirring. C. J. KROM. *Jour. Inst. of Petroleum*, **36** (1950), pp. 727-37.

In the determination of the softening point of asphaltic bitumen, in accordance with I. P. method 58/44, mechanical stirring of the bath is used. This is not done in the A.S.T.M. method D 36-26. Data reported show that stirring the bath reduces the R. and B. softening point for all bitumens by 1.6° C., and hence if stirring is generally used it will involve alterations in all specifications with R. and B. limits. Results with one operator and one apparatus are no better with stirring than without stirring. The conclusion was therefore reached that there is no reason for stirring the bath during the R. and B. softening point determination.

Manufacture: Processes and Plant

Rectifying Column Performance. Effect of Intermittent Reflux. P. T. O'LEARY AND JOHN R. BOWMAN, AND JAMES COULL. *Ind. Eng. Chem.*, **43** (1951), pp. 541-4.

The performance of rectifying columns with intermittent reflux, was studied. In such columns fixed intervals of operation at zero and at total reflux are alternated. Theoretical calculations were made, assuming that both the decay of the distillate composition under zero reflux and the growth at total reflux depend exponentially on time. The formulations resulting indicate that the mean distillate composition from such operation is always of poorer composition than that obtained by continuous reflux at the same ratio, but only slightly poorer under ordinary conditions. Results of the experimental work were found to check theoretical predictions.

Midget Fluid Catalytic Cracking Units. H. W. GROTE, J. HOEKSTRA, AND G. T. TOBIASSON. *Ind. Eng. Chem.*, **43** (1951), pp. 545-50.

The high cost of research and development projects carried out on the pilot plant scale renders it desirable to do as much work as possible on the laboratory scale. However, it is necessary to duplicate the conditions to which the catalyst and feed stock are exposed in actual commercial operation. In the small fluid catalystic cracking plant described continuous operation is effected with full catalyst circulation using approximately one liter of catalyst and employing continuous debutanization and automatic batch fractionation. Study of the data indicates that the essential operating conditions of large scale units were duplicated in the small plants. Midget units permit securing more complete data than from conventional laboratory methods, with no increase in manpower requirements. Much of the work ordinarily done with large pilot plants can be done in the small scale pilot plant in the laboratory. The flow sheet of the small plant is presented together with several photographs and description of the plant itself and operating procedure, including instrumentation and control. Typical operating data are given.

Separation of Gas Mixtures by Mass Diffusion. Part I. MANSON BENEDICT AND ARNOLD BOAS. *Chem. Eng. Progress*, **47** (1951), pp. 51-62.

The separation of the components of a gas mixture by mass diffusion is effected by taking advantage of the different rates of diffusion of the components into steam or other separating agents. The job can be done in a mass diffusion stage, or a mass diffusion column. In the stage type apparatus the mixture can be separated if fed on one side of the diffusion screen, the separating agent on the other. Components of high diffusion coefficients move preferentially through the screen and are discharged with the separating agent, as the head fraction of the operation. When hydrogen or helium with high diffusion coefficients are to be separated from other components, a useful separation can be obtained in a single stage. For a more difficult job, a cascade of stages is needed. In the column type apparatus, steam or other condensable separating agent is caused to flow from one wall of the column, through the mixture being separated, to the other wall, where it is continuously condensed throughout the entire length of the column. By use of a column of sufficient length, any desired degree of separation can be secured. Theoretical equations are presented for the performance of both types of apparatus and are applied to the separation of hydrogen from coke oven gas,

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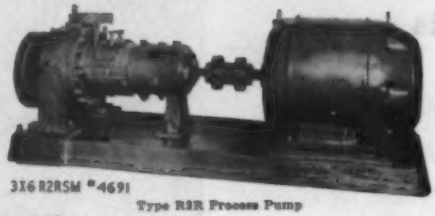

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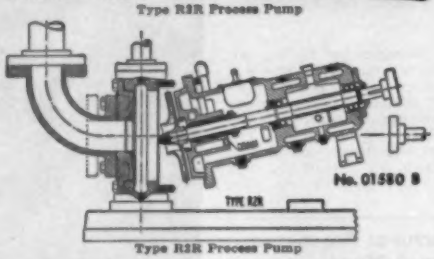

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and for the separation of isotopes. The thermodynamic efficiency of the separation of the column is only 1.1 percent. Since an efficiency of 10 percent is obtained when hydrogen is separated by partial condensation at low temperatures, mass diffusion is at a serious disadvantage as regards operating cost. The main advantage of mass diffusion is the simple equipment required. The equipment of a single stage is even simpler, but it does not permit the relatively complete separation of hydrogen. However, a 50 percent yield of hydrogen, 90 percent pure, from coke over gas is possible in a single stage. The conclusion is reached that the principal applications of mass diffusion will be in the separation of isotopes, and possibly, in the extraction of hydrogen or helium from heavier gases at places where large amounts of low-pressure steam or other condensable vapors are available.

Sweep Diffusion Gas Separation Process. Part I. MARIO T. CICHELLI, W. D. WEATHERFORD, JR., AND JOHN R. BOWMAN. *Chem. Eng. Progress*, **47** (1951), pp. 63-74.

The authors describe a gas separation process termed "sweep diffusion." In this process, a readily condensable vapor is caused to diffuse through a mixture of gases toward a condensing surface. The flowing vapor carries or "sweeps" toward the condensing surface those components of the gas that have lower rates of diffusion through the vapor. A theoretical and mathetical treatment of the subject is presented. The development of the theory has been restricted to the separation of binary gas mixtures by means of a single sweep vapor. The assumption is made that the gases in the separating zone follow the perfect gas laws.

Catalytic Hydro-Desulphurization of Gas Oil: Analysis of the Kinetics of the Reaction. H. HOOG. *Jour. Inst. of Petroleum*, **36** (1950), pp. 738-51.

As the production of high-sulphur crudes become more important, so will the refining of these oils to remove sulphur be of increasing interest. One of the potential methods is hydro-desulphurization, which is normally effected at moderately elevated pressure and temperature by passing the oil vapors and an excess of hydrogen over a catalyst. Catalysts are usually metal oxides or sulphides of the elements of the sixth and eighth groups of the Periodic System, used as such or with a carrier material. In studying two narrow boiling fractions, it was found that the reaction is essentially of the first order, but that there are considerable differences in reaction rates between the lower mol. wt. and heavier sulphur compounds present. When considering only the initial reaction velocity, it was shown that the rate constant was affected not only by the partial pressure of hydrogen, but also by the oil partial pressure. The addition of an inert diluent suppresses the reaction velocity even at constant hydrogen partial pressure. Apparently, the oil molecules are preferentially adsorbed on the catalyst surface, and the remaining free surface is covered with hydrogen. The extent of hydrogen coverage will depend on the hydrogen partial pres-

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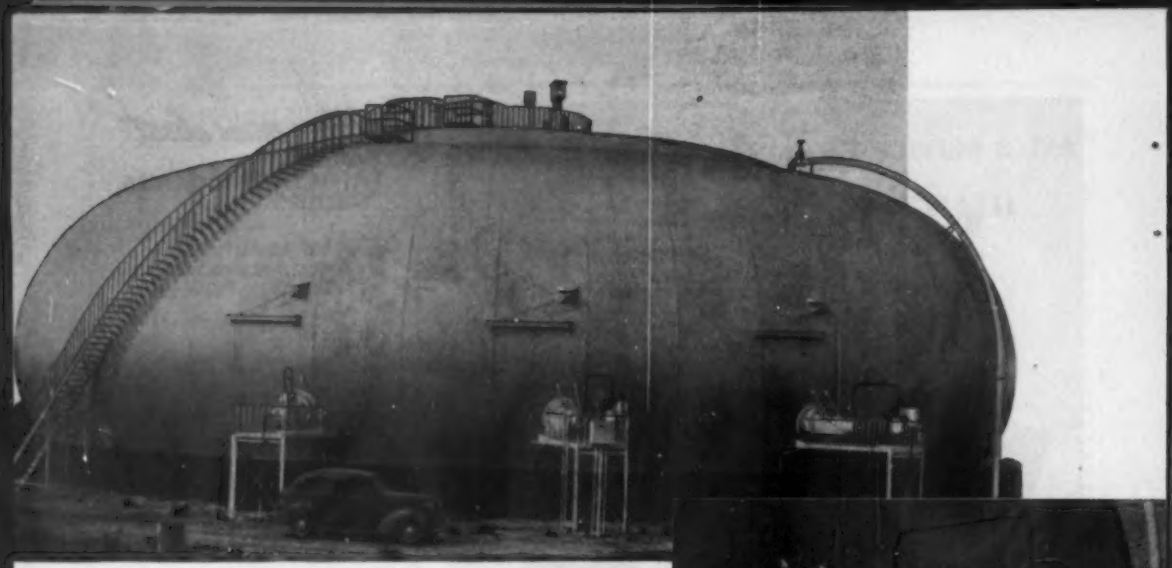

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sure. In case nitrogen is present, this component is also adsorbed, and hydrogen and nitrogen then compete for the available free surface. Hydrogen, however, is adsorbed more readily than nitrogen.

Vapor-Phase Hydrogenation of Light and Heavy Oils. M. L. WOLFSON, M. G. PELIPETZ, A. D. DAMICK, AND E. L. CLARK. *Ind. Eng. Chem.*, **43** (1951), pp. 536-40.

In Germany it was found advantageous in splitting aromatic oils in the gas-oil range to use high-pressure hydrogenation at about 700 atmospheres pressure. A small plant was built suitable for operation at about 500° C. and 10,000 psi. The authors describe the plant and the results of an operation designed to test the activity of a German hydrogenation catalyst to make gasoline from light gas oil derived from coal. The catalyst of chromium-molybdenum-zinc on hydrogen fluoride-activated fuller's earth was found suitable for the hydrogenation operation. On a one-through basis at 500° C., a hydrogen pressure of 9000 pounds per square inch, and a space velocity of 1 kg. of oil per liter of catalyst, the following results were obtained, based on weight percent of the feed: 46.6 percent gasoline, 4.2 C_1 to C_3, and 2.8 percent hydrogen consumption. The content of sulfur, oxygen, and nitrogen was reduced. The gasoline was of high aromatic content and had a motor method octane rating of 79.8. The results in general indicated the suitability of the plant for high pressure catalytic reactions.

Moving Bed Recycle Catalytic Cracking Correlations Product Distribution and Process Variables. J. B. MAERKER, J. W. SCHALL, AND J. C. DART. *Chem. Eng. Progress*, **47** (1951), pp. 95-101.

The authors present the results of a pilot plant study of moving bed recycle catalytic cracking to determine the effect of the process variable recycle-ratio on product quality and yields. The effect of other variables was presented in a previous paper. As a result of study of the correlations developed it was concluded that it is possible to predict the product distribution at a given recycle-ratio and temperature when the yield of one major product is known. Further, the product distribution can be predicted at any given set of operating conditions. Lastly, the operating conditions required at a given temperature and recycle-ratio to obtain a specified yield of one of the major products can be predicted. The correlations developed can be applied to other charge stocks by establishing reference lines on the combination charts with a minimum of three sets of experimental data. The correlations not only are of assistance in the design of commercial units, but also provide a basis for determining the operating conditions for commercial units in order to meet requirements of the particular refiner.

The Manufacture of Furnace Carbon Black from Liquid Hydrocarbons at Ellesmere Port. LOUIS W. CABOT, J. W. EDMINSTER, AND C. A. STOKES. *Jour. Inst. of Petroleum*, **36** (1950), pp. 707-26.

The authors describe a new plant for the manufacture of carbon black from liquid hydrocarbons. Production of car-

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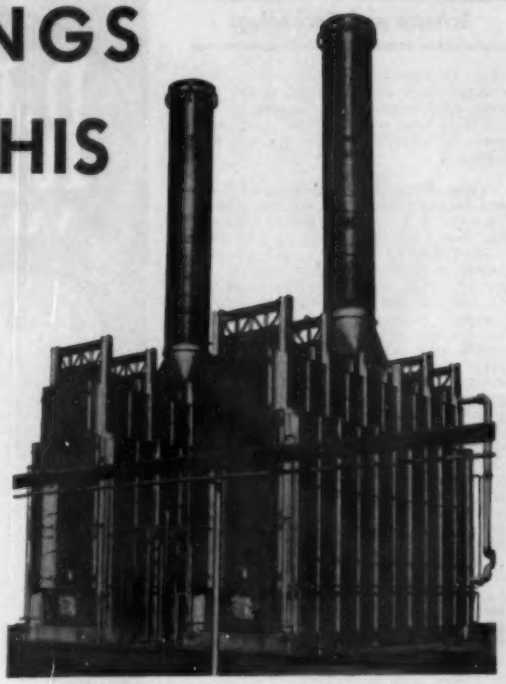

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bon black in Great Britain has been technically and economically possible only since the development of a new process for using liquid hydrocarbons rather than natural gas as raw material. The process gives a carbon black of higher quality than that from gas in several respects. Industrial carbon blacks have mean particle diameter ranging from 10 to 500 milli-microns. About 28 percent of the carbon blacks currently produced in the United States is made from oil. Approximately 50 percent are channel blacks from natural gas, and the remaining 22 percent are thermal and furnace blacks from natural gas. In making carbon black from oil a highly aromatic oil is required. A portion of it is burned in a furnace, thus furnishing the heat for the decomposition of the hydrocarbons. Two or three pounds of carbon black result from one gallon of oil. Gases containing the carbon black are then cooled and run through electrostatic precipitators, followed by a series of cyclones. Fluffy carbon black is collected in a conveyor and is then run through a hammer mill to break up agglomerates. It is then mixed with water to form a slurry, which when mixed with the black forms pellets that are dried to make a product of relatively high bulk density. The residual gases are further cooled and run through a second electrostatic precipitator, then further cooled, and finally burned. The carbon collected in the wet scrubber is used as slurry.

Chemical Composition and Reactions

Sulfur Analogs of Isoquinolines. Werner Herz. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 351-2.

If the benzene ring of isoquinoline is replaced by a thiophene nucleus, three thienopyridines, are obtained. Only one compound of this type has been described in the literature, but in view of the pronounced physiological effects exhibited by naturally-occuring and synthetic isoquinolines, the synthesis of model compounds containing these ring systems is of interest. The Bischler-Napieralski reaction was applied successfully to the acyl derivatives of β-2- and β-3-thienylethylamine. Dehydrogenation of the products yielded representatives of two new ring systems, thieno (2, 3-c) pyridine and thieno (3, 2-c) pyridine. These compounds can be regarded as the sulfur analogs of the 1-substituted isoquinolines.

The Oxidation of Free Methyl Radicals. J. H. Raley, L. M. Porter, F. F. Rust, and W. E. Vaughan. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 15-7.

The oxidation of free methyl radicals at 120° to 160° C. produces methanol, carbon monoxide, formic acid formaldehyde, carbon dioxide, water and traces of hydrogen. No methane or ethane is formed. It was concluded that the only significant reaction of free methyl is that with oxygen to form methylperoxy (CH_3OO) free radical. This radical is apparently transformed to the methoxy radical, and the ultimate formation of methanol, formaldehyde and carbon

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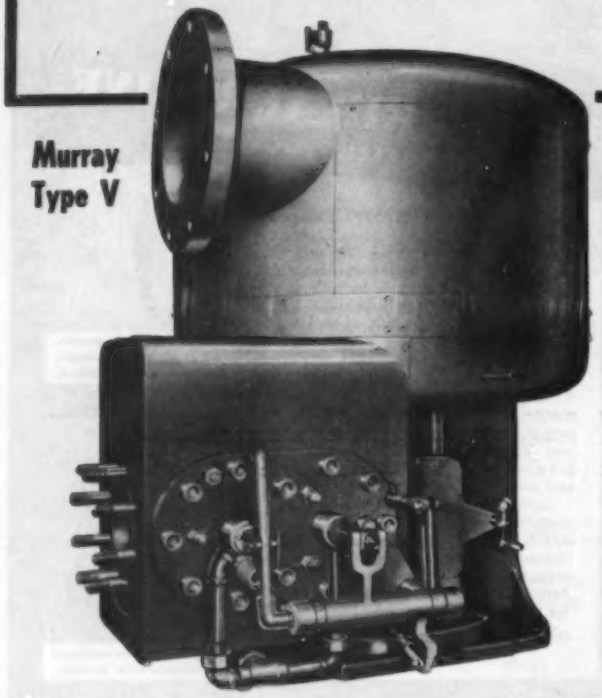

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monoxide are attributed to the reactions of the methoxy radical. The same reactions are observed with methoxy radicals obtained in the cracking of methyl t-butyl peroxide.

Hydrogen Exchange Between Cracking Catalyst and the Butanes. S. G. Hindin, G. A. Mills, and A. G. Oblad. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 278-81.

A study was made of the hydrogen exchange reaction of a typical silica-alumina cracking catalyst, using hydrocarbons of various types. In order to measure the factors critical to the exchange, a detailed study was made of the n-butane and isobutane. The general procedure was either to contact the paraffin with a silica-alumina catalyst that had been enriched with deuterium, or to contact the silica-alumina cracking catalyst containing hydrogen with the mono-deuterated hydrocarbon. An effort was made to ascertain the effect of the structure of the paraffin on reactivity and to determine the effect of other reagents, water, olefin and air, on the exchange.

Deterium Tracers in the Pyrolysis of Butane and Propylene. Charles D. Hurd and Julian L. Azorlosa. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 33-7.

In the pyrolysis of butane or propylene, the extent of decomposition is customarily measured by determining the unchanged butanes or propylene. The question arises as to whether the recovered materials are or are not exclusively the original material. This question was studied by the use of deuterium tracers. The results indicate that the original hydrocarbon recovered after pyrolysis is not exclusively the original unchanged material, but also includes a substantial amount of synthetic material. The free radical mechanism explains these results satisfactorily. The data obtained confirm previous findings that n-butyl participates more actively in butane production than s-butyl.

Hydrogen Transfer Over Silica-Alumina Catalysts. R. W. Blue and C. J. Engle. *Ind. Eng. Chem.*, **43** (1951), pp. 494-501.

Hydrogen transfer as a process separate and distinct from hydrogenation is well recognized. The purpose of the authors was to study some variables in this connection, under conditions mild enough to minimize cracking. The transfer of hydrogen from naphthenes to olefins over nonhydrogenating catalysts is an important reaction in hydrocarbon conversion, and leads to the formation of aromatics and isoparaffins. Cis-Decalin and Tetralin were used as hydrogen donors, and 1-butene and isobutene as hydrogen acceptors. The reaction was studied with respect to catalyst composition, space rate, temperature, and run duration. By using C_{14}-labeled 1-butene the sources of catalyst deposit have also been identified. Isobutene is more reactive as an acceptor than 1-butene. Catalyst deposit is formed largely from olefins at low conversion, but aromatic compounds contribute to the deposit at higher conversions. It was found that co-precipitated silica-alumina catalysts containing 60-90 percent silica were most active for hydrogen transfer, and

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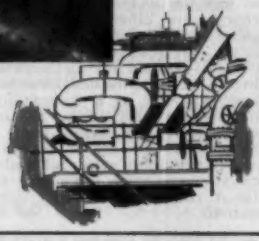

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are least active for hydrogen-deuterium exchange. The conclusion was reached that the mechanism of hydrogen transfer does not involve adsorbed hydrogen "atoms," but rather proceeds by an ionic mechanism over an acid catalyst. The data are presented in considerable detail in tabular and graphical form, and a bibliography of 20 references is included.

Hydrogen-Deuterium Exchange Activity of Silica-Alumina Catalysts. V. C. F. Holm and R. W. Blue. *Ind. Eng. Chem.*, **43** (1951), pp. 501-5.

A hydrogenating catalyst is distinguished from a non-hydrogenating catalyst by its ability to promote dissociation of hydrogen molecules and recombination of hydrogen atoms. The reaction, $H_2 + D_2 = 2HD$, over a solid catalyst involves adsorption and desorption of hydrogen, and must therefore have a close relationship to dissociation and recombination of hydrogen over such catalysts. For this reason the rate of hydrogen-deuterium exchange was measured over a large number of catalysts. Catalysts having from 0.0 to 7.5 percent silica were of the highest activity for hydrogen-deuterium exchange, whereas those in the range 60 to 90 percent silica were found best for hydrogen transfer. The results of the work indicate that hydrogen transfer and hydrogen-deuterium exchange are different processes and require different characteristics in a catalyst. Pretreatment of catalysts at 800° C. rather than 400° C. increased the activity for hydrogen-deuterium exchange as much as a thousandfold in some instances, perhaps as a result of the elimination of water. Even when pretreated at the higher temperature, however, the most active silica-alumina catalysts were much less active than a catalyst commonly used for dehydrogenation.

Distribution and Type of Sulfur Compounds in Straight-Run Naphthas. J. H. Hale, C. J. Thompson, M. G. Barker, H. M. Smith, and J. S. Ball. *Analytical Chem.*, **23** (1951), pp. 287-93.

The purpose of the work recorded was to gain knowledge of the types of sulfur compounds in the napthas from high-sulfur crudes and on the distribution of these compounds with temperature. Seventeen typical high-sulfur crude oils were studied. The naphthas were cut from 212° F. to 482° F. at atmospheric pressure. Other napthas were distilled under a vaccuum of 15 to 20 mm. of mercury, and then on down to a pressure of approximately one mm. The sulphur compounds studied included hydrogen sulfide, free sulfur, mercaptans, disulfides, aliphatic sulfides, aromatic sulfides, and residual sulfur compounds. It was found that the types of sulfur compounds present in the distillates vary widely, depending on the crude oil source and on the temperature of distillation. The residual sulfur compounds, or those that did not react in the scheme of analysis used, were predominant. Little is known of their composition, except that they are changed by heat to more reactive types. The presence of elementary sulfur was established in certain of the crude oils. The effect of heat in changing the types of compounds appearing in the naphthas is significant. Further development of analytical methods will be necessary before the questions raised by the present work can be resolved.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

2,2'-Biquinoline
8-Hydroxycoumarin
Trisilane
2,3,4,6-Tetrachlorobenzaldehyde
2,3,4-Trichlorobenzaldehyde
2,3,5-Trichlorobenzaldehyde
Diamyl naphthenate
Tribromofluoromethane
n-Hexacosane
Trinaphthyl methane
3,3,3-Trifluoropeopene
Benzofuran
Naphthastyril
Aluminum trimethyl
1,1-Diethyl hydrazine
Heptanetriol-2,4,6
1,1,2-Triiodopropane
Chromium hexacarbonyl

Fundamental Physical and Chemical Data

Thermodynamic Properties and Rotational Isomerism of two-Thiabutane. D. W. Scott, H. L. Finke, J. P. McCullough, M. R. Gross, K. D. Williamson, Guy Waddington, and H. M. Huffman. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 261-5.

The heat capacity of two-thiabutane (methyl-ethyl-sulfide) in solid and liquid states was measured over the temperature range 14-298° K. The melting point and heat of fusion were determined. The vapor pressure was measured over the temperature range 23-101° C. and an equation given to represent the data. The heat of vaporization was measured at three temperatures, and the heat capacity of the vapor at five temperatures between 327 and 487° K. Several thermodynamic calculations were made from the data obtained experimentally.

Vapor-Liquid Equilibria in Binary Systems of Hydrocarbons of Various Types. L. Sieg. *Chem. Ing. Tech.*, **22** (1950), pp. 332-6.

Equilibrium data at atmospheric pressure are reported for the systems, benzene and n-heptane, benzene, iso-octane, benzene n-octane, benzene 2, 2, 3-trimethyl-butane, benzene cyclohexane, benzene methylcyclohexane; toluene n-hexane, toluene n-heptane, toluene iso-octane, toluene cyclohexane, toluene methylcyclohexane, p-xylene, and n-octane; and iso-octane and methylcyclohexane. For the system benzene-n-heptane, data are given at several pressures down to 300 mm.

Flame Propagation. II. The Determination of Fundamental Burning Velocities of Hydrocarbons by a Revised Tube Method. Melvin Gerstein, Oscar Levine and Edgar L. Wong. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 418-22.

A procedure is described for determining the rates of flame propogation in tubes. Data are presented for several hydrocarbons including normal and branched alkanes, alkenes and alkynes as well as cyclohexane and benzene. Paraffins have a constant flame velocity except for methane which is slightly lower than the others. Unsaturation increases the flame velocity in the order: alkanes > alkenes > alkynes. Branching of the chain reduces the flame velocity, although the effect is not great.

Flame Propagation. III. Theoretical Consideration of the Burning Velocities of Hydrocarbons. Dorothy Martin Simon. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 422-5.

This is the second paper in the series reporting the determination of maximum fundamental flame velocities for hydrocarbons in air as determined by the tube method. The maximum flame velocities for 35 hydrocarbons including the n-alkanes, branched alkanes, n-alkenes, branched alkenes, benzene and cyclohexane are shown to be consistent with the active particle diffusion theory of flame propogation. The rate constants as calculated from the Tanford and Pease equation for all the hydrocarbons are the same $1.4 + 0.1 \times 10^{-11}$ cc./mole/sec., except for the hydrocarbon ethylene, which is different from the other hydrocarbons. According to the active particle diffusion theory, the rate of flame propagation is considered to depend on the rate of diffusion of active particles, which are the chain carriers of the oxidation reaction. The rate of flame propagation appears to depend on the concentration of hydrogen atoms, oxygen atoms, and hydroxyl radicals in the flame.

Catalytic Appoints Executive Engineer

Thomas George Reynolds has joined the refinery division of Catalytic Construction Company, Philadelphia, as an executive engineer. Reynolds has been associated with petroleum engineering since 1929, when he was an engineering inspector at Standard Oil Co. (Indiana) in Whiting. He was subsequently associated with The M. W. Kellogg Company, Continental Oil Company, Foster Wheeler Corporation, Kellex Corporation and J. F. Pritchard and Company, being chief engineer of the latter company. Prior to joining Catalytic, Reynolds was a process engineer with United Engineers and Constructors of Philadelphia.

Reynolds is a graduate of University of Illinois with a B.S. in Civil Engineering in 1928. He was awarded a masters degree in Chemical Engineering at Columbia University in 1942.

Petrol Changes Name to Texas City Refining, Inc.

Petrol Refining, Inc., of Texas City, which recently changed its name to Texas City Refining, Inc., expects to complete reactivation of its Texas City refinery sometime this month, with a capacity of between 25,000 and 30,000 barrels per day. They will operate a Houdry catalytic cracking unit and a HF alkylation unit under UOP license. The estimated cost of rehabilitation is between $500,000 and $600,000.

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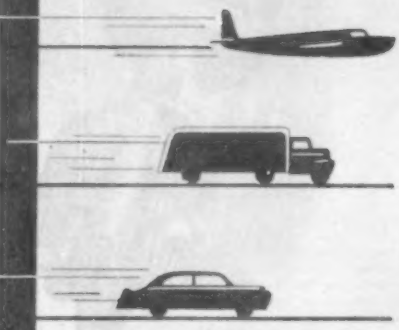

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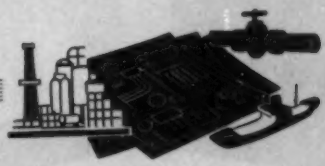

REFINING

U.S.P. 2,537,999. Process for Obtaining Valuable Products from Waxy Hydrocarbon Stocks. D. A. Hermanson and J. L. Biles to Socony Vacuum Oil Company, Inc.

A deoiled waxy product and a gasoline containing product are obtained from a wax bearing high boiling mineral oil by intimately contacting the latter with a particle form solid adsorbent of at least 0.01 inch average diameter. The temperature is maintained at a level at which the wax constituents of the oil are congealed already prior to the initial contacting period in such a manner that the congealed wax constituents remain deposited on the surface of the adsorbent, while the non-congealed liquid is sorbed thereby. The wax is then removed from this surface, whereupon the adsorbent is heated to a temperature at which the non-congealed liquid is converted to a lower boiling gasoline containing product.

U.S.P. 2,538,001. Production of Polyolefinic Hydrocarbons. A. E. Hoffman to Universal Oil Products Company.

For recovering the compounds of a complex of HF with polyolefinic cyclic hydrocrabons containing conjugated and non-conjugated unsaturation, this complex is introduced into a pool of inert liquid, e.g. a paraffinic hydrocarbon fraction, maintained at a temperature of 50-250° C. By thermal decomposition of the complex HF vapors are released which are rapidly removed. The remaining liquid mixture is then distilled to separate the polyolefinic cyclic hydrocarbons from the inert liquid.

U.S.P. 2,538,220. Process for Deasphalting Petroleum Oils. E. E. Willauer to Standard Oil Development Company.

Asphaltic and metallic substances are precipitated from petroleum oil by contacting it with liquefied propane or butane introduced at the bottom of the treating zone. The precipitated asphaltic phase is withdrawn from the bottom of this zone, while the treated oil is withdrawn from the top of this zone where the untreated oil is also introduced.

U.S.P. 2,538,287. Regenerating Alcohol-Caustic Solution. V. Voorhees to Standard Oil Company of Indiana.

Spent caustic methanol solution obtained in the extraction of mercaptans from sour hydrocarbons is heated above the methanol b.p. to distill off a portion of the methanol substantially free of mercaptans. On further heating to a higher temperature, the remaining methanol, together with the mercaptans and water is distilled off. The thus obtained distillate mixture is fractionated to separate the methanol therefrom. Both methanol fractions are then combined with caustic solution from the second distillation zone and form regenerated extracting solution.

U.S.P. 2,538,710. Analytical Method and Apparatus. D. E. Smith to Phillips Petroleum Company.

An apparatus and a method are claimed for quantitatively analyzing a gaseous hydrocarbon-containing mixture.

U.S.P. 2,538,870. Dewaxing Hydrocarbon Oil with Vortex Separator. J. B. Hunter to The Atlantic Refining Company.

In the dewaxing of hydrocarbon oil, an aqueous solution containing a wetting agent, and an immiscible organic solvent containing oil and crystallized wax are tangentially introduced into the upper portion of a confined zone. A free falling whirling vortex is formed the velocity of which is sufficient to cause the solvent and oil to pass radially outwardly through the aqueous solution leaving the crystallized wax suspended in the aqueous solution.

U.S.P. 2,539,005. Adsorption Process. C. H. O. Berg to Union Oil Company of California.

For separating a gaseous mixture such as a mixture of gaseous hydrocarbons, this mixture is contacted with a moving bed of solid granular adsorbent, e.g. activated charcoal. The rich adsorbent formed with the more readily adsorable constituents of the mixture is conveyed in a lift gas comprising constituents of a reflux gas to a rectification zone where this adsorbent is contacted with a portion of the more readily adsorbable constituents to desorb the reflux gas therefrom. The adsorbed constituents are then desorbed as a rich gas product. The lean adsorbent left is cooled and recycled to the adsorption zone.

U.S.P. 2,539,006. Adsorption Apparatus and Process. C. H. O. Berg to Union Oil Company of California.

The process according to this patent is closely related to that of U.S.P. 2,539,005. The rich adsorbent left after removal of the unadsorbed lean gas is here directly contacted with a rich gas reflux to desorb less readily adsorbable constituents, and the thus rectified adsorbent is then lifted by a gas comprising constituents of the rich gas to a heating zone where the remaining rich gas is stripped from the adsorbent.

U.S.P. 2,539,044. Fluid Separation Apparatus. B. R. Walsh to Gulf Research & Development Company.

The construction is claimed of an apparatus for separating gases from liquids. The apparatus mainly consists of an internal-external gear pump provided with a plurality of compartments which vary in volume with rotation of the rotor.

U.S.P. 2,539,074 Electrical Process for Dehydrating Oil. C. C. Grove to Union Oil Company of California.

A petroleum oil containing particles of an aqueous phase dispersed therein as an emulsion, e.g. a wet crude oil, is passed between two electrodes charged with alternating electric current. This current has a continuous sine wave form and a frequency between one million and 100 million cycles per second. The particles of the aqueous phase are agglomerated and are withdrawn from the oil.

U.S.P. 2,539,478. Method of Disposing of Slop Oil. D. C. Robertson to The Standard Oil Company of Ohio.

The interface emulsion of slop oil with an external oil phase is resolved by treating the emulsion at a temperature of at least 125° F. successively with a sulfated or sulfonated organic surface active agent and an agent producing unequal molar concentrations of hydrogen and hydroxyl ions in aqueous solutions. Specified amounts of this latter type of agents are employed depending on whether it is an acid or a base.

U.S.P. 2,539,915. Method of Purifying Boiler Oil. H. O. Lindgren to Aktiebolaget Separator, Stockholm.

Heavy fuel oil or boiler oil containing water and solid impurities is flowed through a heating zone and rapidly heated therein to an emulsion-breaking temperature of 80-95° C. The heated oil is centrifuged before there is any noticeable precipitation of quick-burning asphaltic substances in the oil. The time

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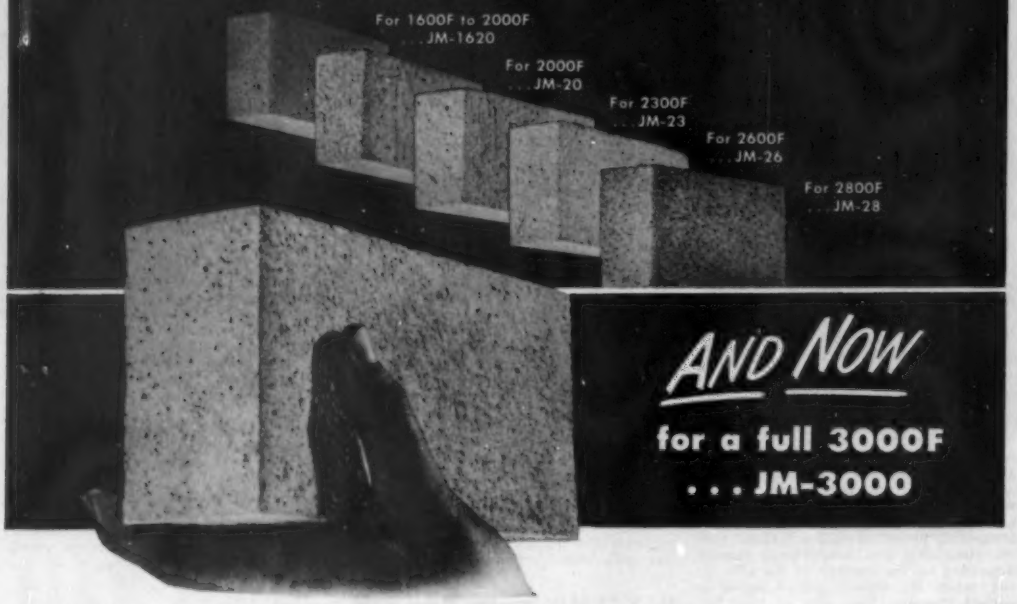

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Linear Shrinkage,† percent	0.0 at 2600 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
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500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.32	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.92	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† 24-hr simulative service panel test for JM-3000, 24-hr soaking period for other brick.

* Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

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of treatment of the oil at the highest temperature shall not be greater than 10 minutes. A fuel suitable for combustion engines, particularly for Diesel engines is obtained by the purifying operation.

U.S.P. 2,540,083. Continuous Extractive Crystallization Process. P. M. Arnold to Phillips Petroleum Company.

Details are claimed of a continuous process for the separation of a hydrocarbon from a mixture with other hydrocarbons having lower m.p.s. by fractional crystallization and by means of a selective extractive material for these other hydrocarbons.

U.S.P. 2,540,129. Separation of Iron from Hydrocarbons. G. G. Lauer and R. S. Pratt to The M. W. Kellogg Company.

A mixture of iron, hydrocarbons and a carbonyl, as obtained, for example in a Fischer-Tropsch synthesis, is treated with an aqueous solution comprising 1-40% by weight of $NaHSO_3$. A ferruginous sulfite is produced without reacting the carbonyl and is separated from the hydrocarbon and carbonyl to remove the iron impurities.

U.S.P. 2,540,143. Separation of Organic Compounds. E. Solomon to M. W. Kellogg Company.

In a process for separating hydrocarbons from an aqueous solution of water-soluble oxygenated organic compounds containing a polar group by extracting this solution with a relatively low-boiling hydrocarbon solvent, the thus formed extract and raffinate phases are separately subjected to fractional distillations in a manner claimed in detail.

U.S.P. 2,540,318. Separation of Narrow Boiling Hydrocarbon Fractions. S. F. Birch, W. Habeshaw and C. B. Collis to Anglo-Iranian Oil Company, Ltd.

A mixture of hydrocarbon boiling in the range of 69-85° C, and essentially consisting of cyclohexane, benezene, 2,2-dimethylenpentane, methlycyclopentane and minor proportions of other hydrocarbons, as obtained as a fraction from petroleum naphtha is decomposed to obtain the separate components by a process claimed in detail including repeated fractionation connected with an isomerization conversion operation.

U.S.P. 2,540,437. Treatment of Emulsions. F. E. Fuchs to Aquanox Corporation.

A water-in-oil petroleum emulsion is broken by treatment with an agent consisting of 15-3% of a polyoxyalkylene derivative of hexitol anhydride partially esterified with a long chain fatty acid, and 85-97% of a mixture of water-soluble mahogany and green acid soaps and an oxidized fatty body.

U.S.P. 2,540,438. Demulsifier Composition. F. E. Fuchs to Aquanox Corporation.

The demulsifier according to this patent is closely related to that employed in U.S.P. 2,540,437. A castor oil modified alkyd resin is also used therein.

U.S.P. 2,540,977. Continuous Fractional Crystallization Process. P. M. Arnold to Phillips Petroleum Company.

Details of a continuous process are claimed for the separation of a hydrocarbon from a mixture containing other hydrocarbon with lower m.p.s., e.g. for the separation of cyclohexane from an isoheptane fraction containing it. Multi-component crystals including said hydrocarbon are first formed by cooling and then separated by fractional crystallization.

CATALYST PREPARATION, ACTIVATION AND REGENERATION

U.S.P. 2,538,345. Process for the Manufacture of Aluminum Halide Catalysts. T. H. Whaley, Jr., to Phillips Petroleum Company.

Aluminum halide is heated under superatmospheric pressure in excess of its vapor pressure and up to 150 psi. A fluid mass is formed which is shaped into pellets of 0.1-0.5 inches in diameter while under this pressure. The pellets are cooled while under this pressure to a temperature below the softening point of the halide at atmospheric pressure. Smooth, hard, dense catalytic pellets are thus obtained.

U.S.P. 2,540,109. Process for Reactivating Catalysts. A. H. Friedman to Phillips Petroleum Company.

A Fischer-Tropsch synthesis catalyst deactivated by deposition of wax is contacted for reactivation with syn-

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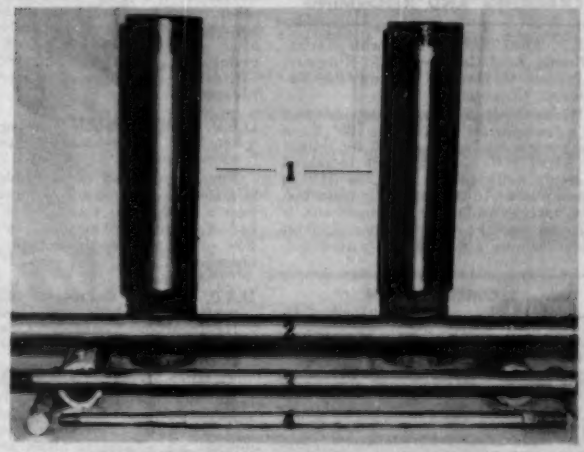

(1) Pump plungers, 6" dia., x 17¾" on metallized section. Sprayed with 420 Stainless on cast iron. (2) Compressor Rod, 2½" dia., by 42¼" long on metallized section. 420 Stainless on 3140 steel. (3) Pump rod 1-11/16" dia. by 28½" long. 420 Stainless on cold-rolled. (4) Pump rod 1⅛" dia. by 18½". 420 on bronze.

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thesis gas mixture at a space velocity below that at which any substantial yield of hydrocarbons is effected at a temperature and for a period of time such that the wax is removed from the catalyst. This regeneration can be combined with the synthesis operation by temporarily decreasing the space velocity of the synthesis gas to the indicated degree.

U.S.P. 2,540,599. Catalyst for the Synthesis of Hydrocarbons. M. A. Segura to Standard Oil Development Company.

The fragmentation of a hydrocarbon synthesis catalyst consisting of iron particles caused by forces accompanying the deposition of carbonaceous material on the catalyst during the synthesis operation is retarded by bonding the iron particles together by an organic thermosetting resinous material.

U.S.P. 2,540.689. Coprecipitated Alumina Magnesia Silica Catalyst. D. Porret to Ciba Ltd., Basel.

A catalyst, especially useful for isomerization is produced by adding an aqueous solution of an aluminum salt and a magnesium salt to an aqueous solution of an alkali metasilicate containing an amount of alkali sufficient to precipitate the excess of Al and Mg salts. The resulting precipitates are treated with water under addition of an alkaline earth metal hydroxide at elevated temperature. The ratio of metasilicate to the Al and Mg salt shall be 1:1.4 to 1:10.

CRACKING AND REFORMING

U.S.P. 2,540,379. Cracking with Hydrofluoric Acid Catalyst. J. A. Ridgway, Jr., and P. Hill to Pan American Refining Corporation.

Heavy hydrocarbon oils are cracked at a temperature of at least 100° C. in the presence of at least 50% by weight of liquid HF catalyst under increased pressure sufficient to keep the HF in liquid phase. An isoparaffin hydrocarbon gas, such as isobutane or isopentane, is injected into the reaction zone. Lighter hydrocarbons, e.g. gasoline are produced.

ISOMERIZATION

U.S.P. 2.538,248. Isomerization of Olefins. V. N. Ipatieff and G. S. Monroe to Universal Oil Products Company.

An olefin with more than 3 C atoms is subjected to the action of a copper-nickel-silica catalyst containing a major proportion of nickel at a temperature of 150-450° C. to cause isomerization of the olefin.

ALKYLATION

U.S.P. 2,538.262. Method of Purifying Sulfuric Acid Alkylates. M. J. Murray to Universal Oil Products Company.

In the alkylation of hydrocarbons by H_2SO_4, the alkylate formed is contaced in liquid phase with an aqueous washing liquid comprising a solvent for the sulfonic acids present by introducing one of these liquids into the other in the form of droplets greater than 0.1 mm in diameter, so that the droplets pass through the body of the other liquids in a vertical direction. An oily alkylated phase formed is then separated from an aqueous phase containing the water-soluble sulfonic acids.

U.S.P. 2,538,350. Alkylation Process. M. H. Gorin and L. G. Sharp to Socony-Vacuum Oil Company, Inc.

Propylene is contacted with isobutane at a temperature of 20-100° C. in the presence of $AlBr_3$ catalyst dissolved in a saturated hydrocarbon in a concentration of 0.63-5% by weight of the isobutane. An alkylation product is formed which contains at least 70% of aviation gasoline boiling range hydrocarbon.

POLYMERIZATION AND CONVERSION

U.S.P. 2,538,030. Apparatus for Contacting Fluent Solids with Gases. R. H. Newton to Houdry Process Corporation.

The apparatus for contacing fluent solids with gases, e.g., for heating solid catalyst, is provided with flow restricting means in the shape of a grid for the fluent solids gravitating downwardly through a container. This means restricts flow to the greatest extent adjacent to the outlet opening of the container. The grid is so positioned that the angle to the horizontal formed by a line from the outlet opening to the portion of the grid most distant from this opening is greater than the angle of repose. Solids introduced at the top of the container after distributing over the upper surface of a bed of these solids, moves downwardly throughout the area of the bed at substantially equal rates through the grid.

U.S.P. 2,538,260. Diacetyl as Shortstop in Butadiene-1, 3 Emulsion Polymerization. W. E. Messer and J. A. Reynolds to United States Rubber Company.

In the emulsion polymerization of butadienes-1, 3 or mixture thereof with other copolymerizable compounds, an amount of 0.05-1% of diacetyl is added after polymerization of 70-95% of the material originally present to stop polymerization of unreacted material still present.

U.S.P. 2,538.472 Pebble Heating Chamber. S. P. Robinson to Phillips Petroleum Company.

The construction of a pebble heater is claimed which allows to more evenly heat a given cross-section of a flowing bed of pebbles and provides more even flow of the pebbles through the heating chamber.

U.S.P. 2,538,761. Copolymer of Chloromaleic Anhydride and Unsaturated Hydrocarbons Containing One Double Bond. P. G. Carpenter to Hercules Powder Company.

An aliphatic or sycloaliphatic unsaturated monoolefin is copolymerized with chloromaleic anhydride in a molar ratio of 1:1 to 10:1. The resulting new compounds are soluble in alkali and insoluble in aliphatic hydrocarbons.

U.S.P. 2.539,523. Polymerization of Olefin Mixtures. J. C. Reid, Jr., to The Atlantic Refining Company.

Alpha methyl styrene, isopropene, and isobutylene are copolymerized in solution in about 1.5 volumes of ethyl chloride at a temperature of about—110° C. in the presence of a 1% solution of $AlCl_3$ in ethyl chloride. The ratio of the reactant monomers shall be about 10:3:87. A copolymer of uniform composition and physical properties is produced. Additional amounts of $AlCl_3$ and alpha methyl styrene are added as the copolymerization progresses to maintain a reactant mixture of constant composition.

U.S.P. 2,539,583 Catalytic Conversion of Hydrocarbons with Finely Divided Catalyst in Two Stages. G. F. Kuhn to Sinclair Refining Company.

In the pyrolytic conversion of hydrocarbons, a vaporized charge oil with a finely divided catalyst suspended therein is passed to an initial conversion chamber. The partly converted vapors are withdrawn from an upper zone of this chamber and passed directly with residual catalyst suspended therein to a lower zone of a second conversion chamber. Catalyst withdrawn from a lower zone of the initial conversion chamber is passed to an upper zone of the second chamber. The flow of the catalyst is channeled alternately towards and away from the periphery of the chamber to cause the catalyst to flow across the rising stream of vapors.

U.S.P. 2,540,373. Apparatus for Conversion of Hydrocarbons. J. McAfee to Universal Oil Products Company.

The construction is claimed of an apparatus for the conversion of fluid reactants in the presence of finely divided solid particles and a super-heated gaseous medium.

U.S.P. 2.540.706. Process and Apparatus for Effecting Catalytic Reactions. R. A. Beck and A. J. Millendorf to The Texas Company.

Details are claimed of a process for the catalytic conversion of fluid reactants into different chemical compounds, such as the synthesis of hydrocarbons from CO and H_2. The catalyst mass is subjected to mechanical agitation in the reaction zone while the reactants are passed upwardly therethrough.

U.S.P. 2,540,949. Polymerization of Vinylcyclopropane and its Homologues and Derivatives. J. P. Jones to Phillips Petroleum Company.

Vinylcyclopropane alone or in mixture with styrene or acrylonitrile is polymerized, preferably in aqueous emulsion, in the presence of a peroxide catalyst. High molecular weight polymers are produced.

U.S.P. 2,540,950. Polymerization of Vinylcyclopropane. J. P. Jones to Phillips Petroleum Company.

The process of this patent is closely related to that of U.S.P. 2,540,949. In

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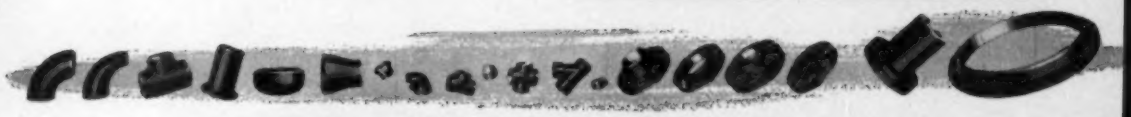

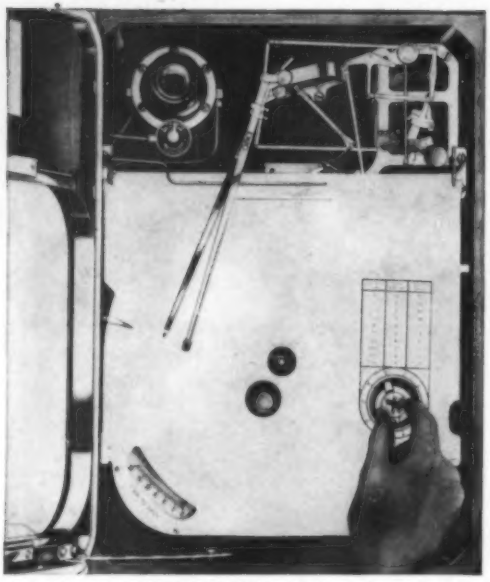

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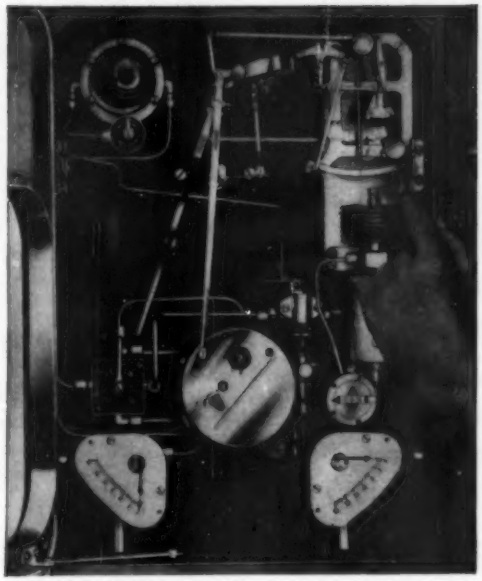

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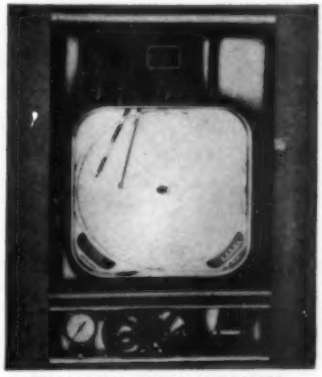

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the present case vinylcyclopropane alone or mixed with isobutylene is polymerized in the presence of a Friedel-Crafts catalyst.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,537,968. Hydrogenation of Aromatic Compounds. W. J. Cerveny to Koppers Company, Inc.

In the catalytic hydrogenation of naphthalene and other unsaturated aromatic compounds, hydrogen is passed upwardly through a liquid mass encompassing a bed of catalyst, such as metallic Ni. The liquid mass comprises hydrogenatable material and has a b.p. within the hydrogenation temperature range of the catalyst. Continuous reflux is maintained over the liquid mass to maintain its temperature at its b.p. Make-up liquid is continuously introduced to the liquid mass while liquid is continuously withdrawn therefrom, at a rate to maintain the liquid level of the liquid mass above the top of the catalyst bed. Hydrogenated compounds are separated from the withdrawn liquid.

U.S.P. 2,538,219. Coal Gassification. A B. Welty, Jr. to Standard Oil Development Company.

Solid carbonaceous material is converted into a commercial mixture containing CO and H_2 by a water-gas operation with the use of inert particles of fluidizable size and carbonaceous particles of non-fluidizable size gravitating downwardly through the reaction zone as a loosely compacted bed counter-current to a stream of steam suspending the inert particles introduced. Details of the process are claimed.

U.S.P. 2,538,235. Hydrogen Manufacture. J. F. Coffey to Standard Oil Company of Indiana.

Hydrogen is produced from a mixture of carbonaceous material and calcium carbonate of small particle size in a water-gas process claimed in detail. The calcium oxide produced during the process by calcining the carbonate is reconverted to the carbonate in a later part of the process.

U.S.P. 2,538,738. Process and Apparatus for Carrying out Exothermic Reactions. L. A. Stengel to Commercial Solvents Corporation.

Details of a process and an apparatus are claimed for the production of methanol from CO and H_2 and for other exothermic reactions. The apparatus allows very efficient cooling of the reaction mixture and maintaining of a uniform temperature throughout the catalyst bed by the arrangement of two series of tubes in the catalyst bed with openings in opposite ends of this bed. Reaction gases are passed in opposite directions through these tubes out of contact with the catalyst.

U.S.P. 2,539,118-9. Manufacture of Carburetted Water Gas. S. P. Cauley to Socony-Vacuum Oil Company, Inc.

Water gas formed by reacting steam with incandescent carbon is passed to-

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gether with petroleum oil and a small proportion of quinoline, diphenylamine, benzyl aniline, or phenyl-acetonitrile added to this oil into a cracking chamber where the oil is cracked to form normally gaseous hydrocarbons. The carburetted water gas formed is characterized by a lower sp. g. than such gas produced without any of said additives. According to U.S.P. 2,539,119 elementary sulfur or an aliphatic sulfur compound are employed as the additive in place of those mentioned before. A carburetted water gas of increased sp. g. is thus obtained.

U.S.P. 2,539,393. Method for the Separation of a Heterogeneous Mixture of Compounds. G. B. Arnold and H. V. Hess to The Texas Company.

The product mixture obtained in a Fischer-Tropsch synthesis process is separated into a liquid hydrocarbon-rich phase and a water-rich phase at a temperature of 175-300° F. and a pressure sufficient to maintain substantial liquid conditions. The water-rich phase is countercurrently extracted with a hydrocarbon solvent under similar conditions of temperature and pressure. The extract obtained is combined with the hydrocarbon-rich phase, and the mixture thus formed is contacted with ammonia under similar conditions of temperature and pressure to form hydrocarbon-insoluble ammonia complexes and ammonia salts of organic acids. Aldehydes are regenerated from the ammonia complexes.

U.S.P. 2,539,414 Catayltic Reduction of Carbon Oxide by Hydrogen. W. G. Frankenburg to Hydrocarbon Research, Inc.

A CO/H_2 mixture is contacted with a catalyst consisting essentially of a tungsten carbide at a temperature of 400-700° F. with a pressure of atmospheric to 500 psi. Liquid hydrocarbons are recovered.

U.S.P. 2,539,415. Process and Apparatus for the Synthesis of Hydrocarbons. P. W. Garbo to Hydrocarbon Research, Inc.

In a Fischer-Tropsch synthesis, a gaseous fluidizing stream is injected into the lower portion of the reaction zone to maintain the catalyst particles in dense fluid phase condition with an upper pseudo-liquid surface. A reactant stream is passed in a path of flow extending upwardly and internally through the fluid phase mass of catalyst out of contact and in indirect heat exchange relationship thereto. The entire reactant stream is injected into the dense fluid phase catalyst along the upward path of flow in successive portions the uppermost of which is disposed substantially below the pseudo-liquid surface.

U.S.P. 2,539,434. Synthesis of Hydrocarbons. P. C. Keith to Hydrocarbon Research, Inc.

When a synthesis gas generated at a temperature above 1800° F. is subjected to a Fischer-Tropsch synthesis at a lower elevated temperature, hydrocarbons are injected into the hot synthesis gas at the temperature above 1800° F. to heat them to cracking temperature. The mixture of synthesis gas and cracking products is then subjected to the synthesis conversion. A product of improved value is produced.

U.S.P. 2,539,466. Process for Carrying out Endothermic Chemical Reactions. V. F. Parry, Golden, Colo.

Details are claimed of a process for producing synthesis gas from subbituminous coal or the like and of other endothermic processes.

U.S.P. 2,539.847. Synthesis of Organic Compounds. H. G. McGrath to M. W. Kellogg Company.

A CO/H_2 mixture is passed through a mass of finely divided contact material consisting by weight of one part CO promoted with 0.05-0.5 part thoria and supported on 0.5-3 parts acid treated bentonite at a velocity effective to suspended said mass in the gaseous stream. A temperature of 350-450° F., a pressure of 150-300 psi, and a CO_2 concentration of the gaseous feed of less than 2% are maintained. Oxygenated organic compounds are obtained as the main products. A liquid hydrocarbon fraction recovered from the effluent and containing a portion of the oxygenated compounds is recycled to increase the yield of oxygenated organic compounds.

U.S.P. 2,540,581. Method of Making Gasoline. C. E. Hemminger to Standard Oil Development Company.

In a Fischer-Tropsch hydrocarbon synthesis in the presence of a fluidized iron catalyst at a temperature of 600-

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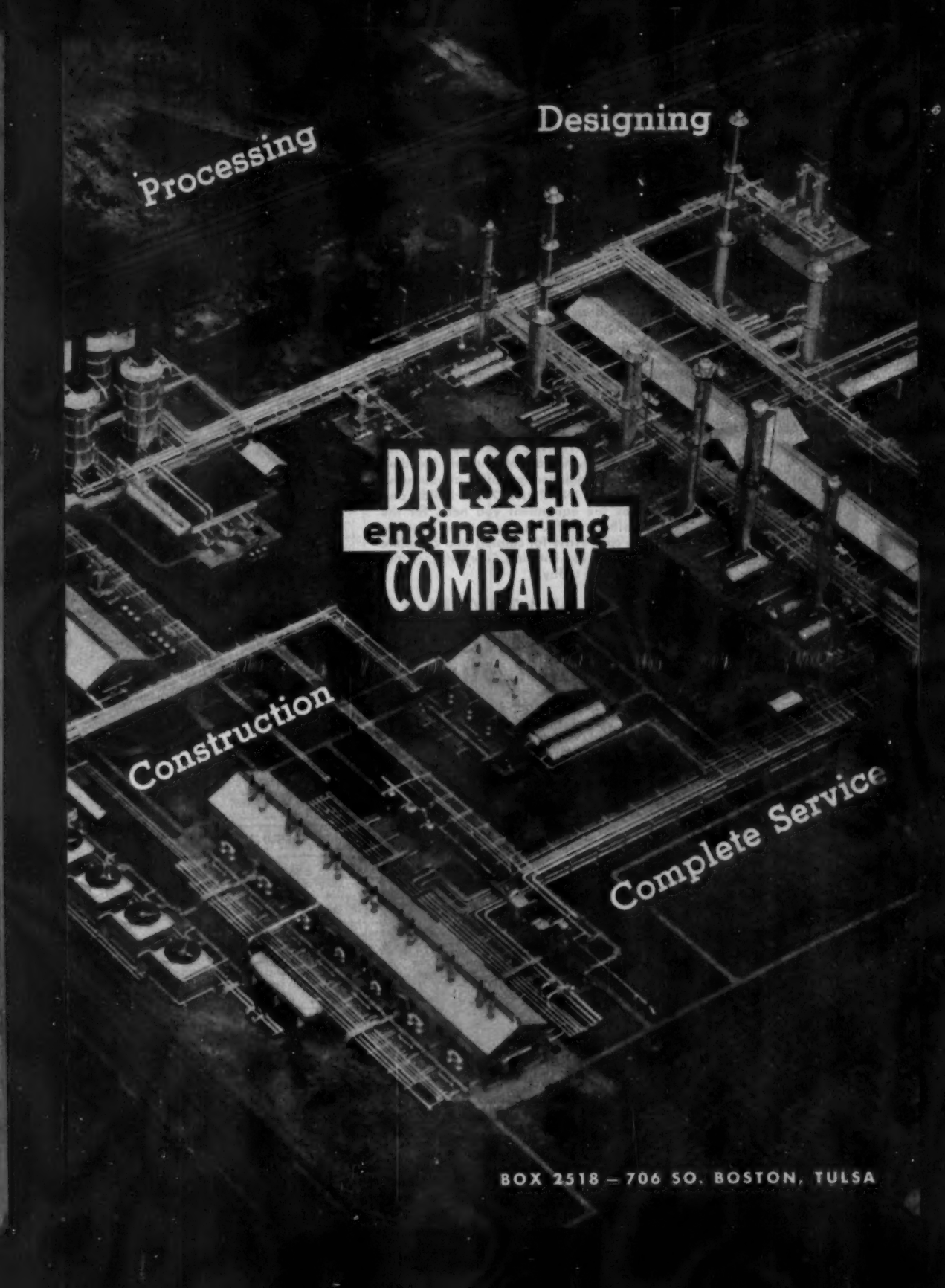
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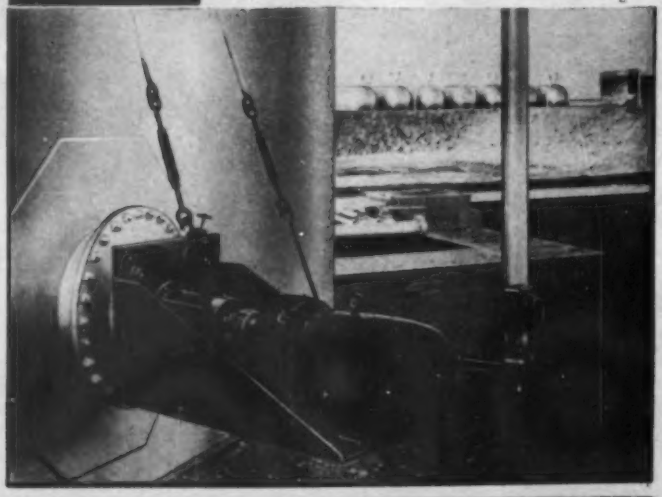

Patents

700° F. and a pressure of 400-450 psi., a space velocity of 10-200 volumes of feed gas per pound of catalyst per hour is maintained and water is added to limit the degree of hydrogen conversion not to exceed 90%. After cooling the reaction effluent, the uncondensed gases are treated together with fresh feed in a second reactor containing a bed of fluidized iron catalyst. At least a portion of the carbon-containing catalyst from the first reactor is passed to the second one, where a temperature 100-150° F. higher than that in the first reactor is maintained. Conversion of at least 93% of the total CO/H_2 feed to the system is effected.

U.S.P. 2,540,582. Hydrogenation. W. G. Hockberger to Standard Oil Development Company.

High boiling residues from petroleum sources liable to decompose during distillation, cracked naphtha fraction which contain or tend to form gum and coke on evaporation, and the like are preconditioned and then hydrogenated by preheating the material to a temperature below the normal b.p. of a component thereof to be hydrogenated. The liquid material is stripped of this component by preheated hydrogen, and the vapor of this component is then carried to a hydrogenation zone together with the preheated hydrogen.

U.S.P. 2,540,587. Process for Producing Hydrocarbons. J. B. Litton and J. C. Schiller to Standard Oil Development Company.

CO and H_2 are reacted at a temperature of 300-700° F. and a pressure between atmosphere and 500 psi. in the presence of a group VIII catayist. The reaction effluent containing hydrocarbons and oxygenated hydrocarbons is passed without condensation directly through an alumina base dehydrating catalyst maintained in a separate zone under dehydrating conditions at a temperature of 300-800° F. and a pressure between atmospheric and 500 psi. Dehydratable oxygenated compounds of the mixture are converted to unsaturated hydrocarbons.

DESULFURIZATION

U.S.P. 2,539,808. Treatment of Hydrocarbon Oils. G. M. Brooner to Phillips Petroleum Company.

Details are claimed of a process for sweetening a sour low boiling hydrocarbon stream by contacting it in the presence of added oxygen with an adsorbent material impregnated with a copper salt and a halide in the presence of a small portion of water.

HEAVY OILS AND WAXES

U.S.P. 2,534,053. Lubricating Grease Containing Paraffin Wax. R. O'Halloran to Standard Oil Development Company.

A mineral lubricating oil of 100-1000 S.U.S. viscosity at 100° F. is thickened to grease consistency with predominantly alkali metal soaps of saturated

Five Santolubes to improve premium and heavy-duty oils

Added to your premium and heavy-duty lubricants, the Monsanto Santolubes, listed below, help your products deliver top performance. These Santolubes have two functions: (1) to inhibit oxidation; (2) to keep motors clean. For information write MONSANTO CHEMICAL COMPANY, Petroleum Chemicals Department, 1700 South Second Street, St. Louis 4, Missouri.

SANTOLUBE 379

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	0.97
Viscosity, S.U.S. at 210° F.	53
Color, ASTM (diluted)	4½
% Phosphorus	0.6
% Sulfur	5.7
% Barium	3.8

Applications: Motor-oil additive which combines the properties of detergency, dispersancy, corrosion inhibition and pour-point depression.

Literature: Technical Bulletin No. O-68

SANTOLUBE 360

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	0.97
Viscosity, S.U.S. at 210° F.	50
Color, ASTM (diluted)	3
% Phosphorus	0.5
% Sulfur	5.1
% Barium	4.0

Applications: A multifunctional agent, combining, in a single additive, detergency, dispersancy and corrosion inhibition. An effective pour-point depressant.

Literature: Technical Bulletin No. O-66.

SANTOLUBE 388

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	1.00
Viscosity S.U.S. at 210° F.	55
Color ASTM (diluted)	5
% Phosphorus	.5
% Sulfur	5.4
% Barium	6.1

Applications: Heavy-duty oil additive. Suitable for meeting current military specifications.

SANTOLUBE 374

Type: Detergent-dispersant-inhibitor type additive

Typical Properties:

Specific Gravity at 60°/60° F.	0.98
Viscosity, S.U.S. at 210° F.	50
Color, ASTM (diluted)	5
% Phosphorus	0.8
% Sulfur	6.6
% Barium	3.6

Applications: A single motor-oil additive that combines detergency, dispersancy, corrosion inhibition and pour-point depression.

Literature: Technical Bulletin No. O-67

SANTOLUBE 395X

Type: Antioxidant and bearing-corrosion inhibitor.

Typical Properties:

Specific Gravity at 60°/60° F.	1.01
Viscosity S.U.S. at 210° F.	75
Color ASTM (diluted)	4
% Phosphorus	3.8
% Sulfur	10.5
% Barium	1.1

Applications: Recommended for compounding premium-type motor oils.

Literature: Technical Bulletin No. O-56.

MONSANTO PETROLEUM ADDITIVES

Pour-point depressants
SANTOPOUR®
SANTOPOUR B
SANTOPOUR C

Motor-oil inhibitors
SANTOLUBE® 395-X, 394-C

Viscosity-index improver
SANTODEX®

Gear-lubricant additives to meet requirements of Federal specification VV-L-761
SANTOPOID® S, S-RI

Gear-lubricant additives to meet requirements of military specification MIL-L-2105
SANTOPOID 29, 32, 33

Motor-oil detergents
SANTOLUBE 203-A, 393-A, 520

Corrosion inhibitor for distillate fuels
SANTOLENE® C

Sludge inhibitor for domestic fuel oils
SANTOLENE E

Cutting-oil additive
SANTOLUBE 32

Inhibitor-detergent combinations for premium and heavy-duty service
SANTOLUBE 205, 206, 380, 374, 379, 388, 521, 522

*Reg. U. S. Pat. Off.

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fatty acids. The composition contains 2-5 percent by weight of paraffin wax with a melting point of 110-135° F. High temperature life of the composition in antifriction bearings is improved by the additive.

U.S.P. 2,534,217. Lubricant Comprising Reaction Product of an Olefin, a Phosphorous Sulfide and Water. J. D. Bartleson to The Standard Oil Company of Ohio.

A mineral lubricating oil composition contains 0.5-50 percent of the reaction product of one mol olefin, 0.2-2.0 mols of a phosphorous sulfide, and 0.5-3 mols of water per mol of the sulfide, treated under special conditions. An extreme pressure lubricant is formed.

U.S.P. 2,535,024. Lubricating Compositions. C. E. Funk, Jr., to American Cyanamid Company.

A heavy metal salt of an oil-soluble ester of dithiophosphoric acid is dissolved in mineral oil by a method claimed in detail.

U.S.P. 2,535,101. Sulfonate Base Lubricating Grease. L. W. Sproule and W. C. Pattenden to Standard Oil Development Company.

A mineral lubricating oil is compounded with a 5-25 percent of an oil-soluble sulfonate, the sulfonate radical of which has a mol weight of 300-500, and 3-20 percent of an insoluble sulfonate, the acid of which has a mol weight of 96-250. The additives impart a grease-like consistency to the oil.

U.S.P. 2,536,684. Sulfurized Product and Preparation Thereof. D. Harman and W. E. Vaughan to Shell Development Company.

The lubricating composition described comprises a major proportion of a mineral oil lubricant and a minor amount of a polymeric alkylene oxide reaction product with P_2S_5. The additive imparts extreme pressure properties to the composition.

U.S.P. 2,536,685. Synthetic Lubricant. D. Harman and W. E. Vaughan to Shell Development Company.

An extreme pressure lubricating composition consists of an oxygen-containing lubricating oil and a reaction product obtained from polyoxyalkylene fluids and a phosphorous halide.

U.S.P. 2,538,066. Manufacture of Lubricating Oil. T. J. Walsh, G. L. Ladd and D. W. Heil to The Standard Oil Company of Ohio.

Details are claimed of a method for producing lubricating oil blending stocks from a distillate fraction including both the light non-viscous and the heavier machine oils.

U.S.P. 2,538,293. Process for Fluosulfonic Acid Refining of Lubricating Oil. P. H. Carnell to Phillips Petroleum Company.

A lubricating oil is treated with fluosulfonic acid in the presence of a low-boiling hydrocarbon. An oil phase and an acid phase are formed. A lubricating oil of improved viscosity index is recovered from the oil phase.

U.S.P. 2,538,321. Treatment of Lubricating Oils. M. E. Nash to Phillips Petroleum Company.

A lubricating oil is thoroughly agitated with a mixture of anhydrous HF and SO_3 at sufficient pressure to maintain HF and SO_3 substantially liquid, and at a temperature of—20° to 50° C. for 30-300 minutes. An oil of improved viscosity index is obtained.

U.S.P. 2,538,696. Lubricant Composition. R. L. May to Sinclair Refining Company.

A petroleum lubricating oil contains a minor amount of an oxidation inhibitor resulting from the reaction of an alkylated phenol with the condensation product of turpentine and P_2S_5, and a minor amount of a Ca or Ba petroleum sulfonate to at least neutralize excess of phosphorus acidity.

U.S.P. 2,539,422. Lubricating Oil. C. Hoffman, T. R. Schweitzer, M. H. Anwar, and G. Dalby to Ward Baking Company.

A crank case oil contains 0.05-1 percent of a compound of the formula (R, R', R")HN-SO_3-Y wherein R is a cyclohexyl radical, R' and R" are alkyl groups with not more than 3 C atoms, and Y is a normal primary aliphatic hydrocarbon radical with 8-20 C atoms. The additive inhibits emulsion formation.

U.S.P. 2,539,424. Esters of P_2S_5-Amine Reaction Products as Lubricating Oil Additives and Lubricants Containing Same. E. C. Hughes and J. D. Bartle-

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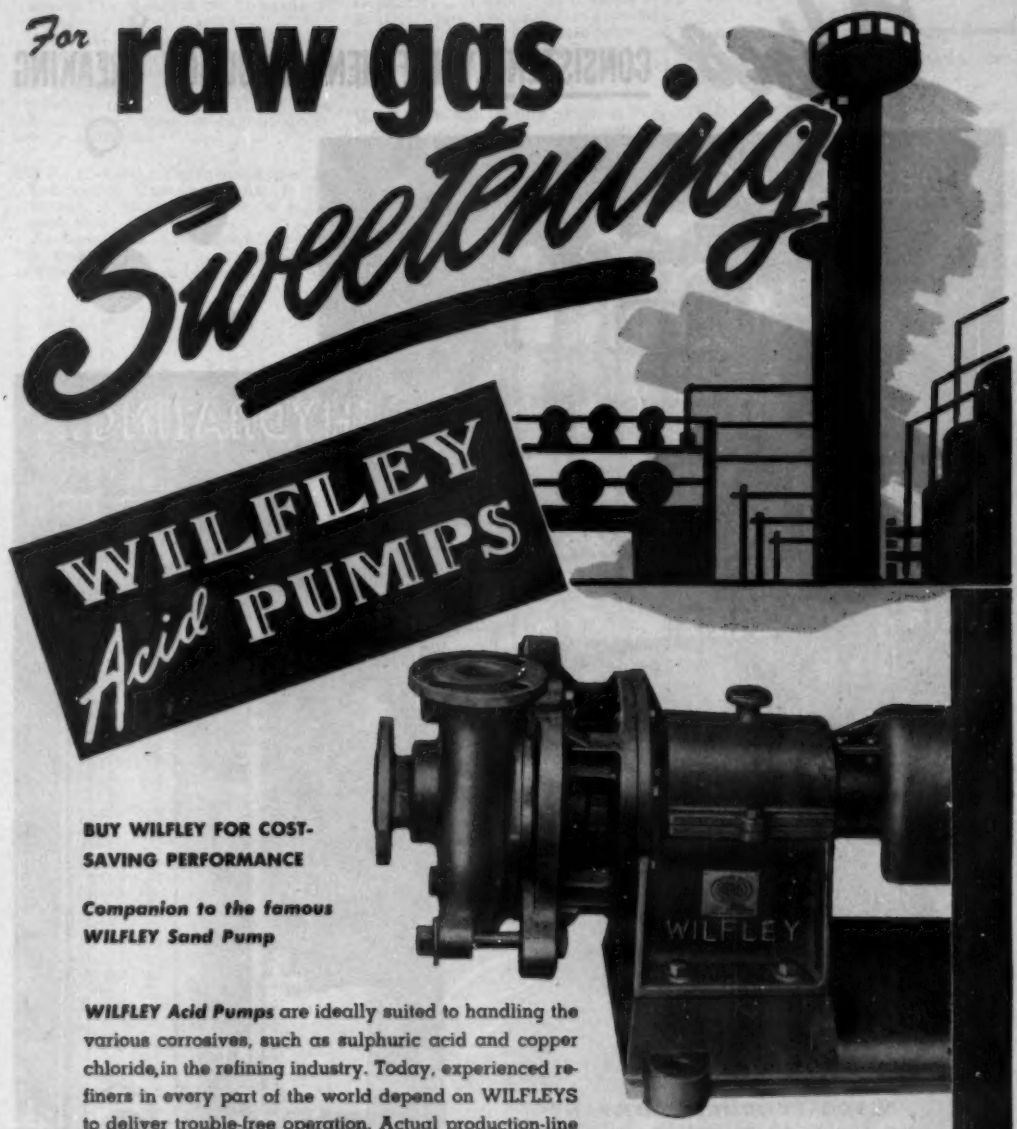

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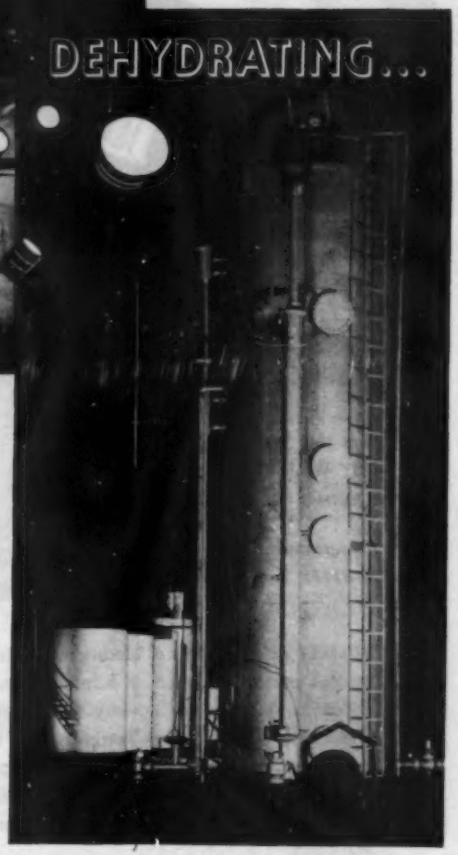

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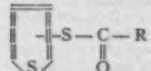
son to The Standard Oil Company of Ohio.

A mineral lubricating oil contains 0.05-10 percent by weight of a reaction product of a certain class of aliphatic amines and phosphorus sulfide esterified by an aliphatic alcohol or phenol. The additive inhibits deterioration of the oil under service conditions.

U.S.P. 2,540,093. Thienylthiolesters in Lubricating Compositions. J. W. Brooks to Socony-Vacuum Oil Company, Inc.

A mineral oil composition contains less than 10 percent by weight of an additive of the general formula:



where R is an alkyl, aryl, or heterocyclic radical. The additive works as an oxidation stabilizer.

U.S.P. 2,540,114. Hydrocarbon Additive Oils. C. Hoffman, T. R. Schweitzer, M. H. Anwar and G. Dalby to Ward Baking Company.

A hydrocarbon oil contains 0.05-1 percent of a reaction product formed by heating above 140° C. until oil soluble: 4 parts by weight of sodium penta alkyl tripoly phosphate having an alkyl chain group of 6-10 C atoms, and at least 5 parts of a sodium sulfonate of a saturated alkyl dibasic acid ester or a secondary alkyl sodium sulfate with a chain of 11-18 C atoms. The additive inhibits the formation of water emulsions and of gummy or varnish-like materials in hydrocarbon oils, improves the penetrating power and the strength of film of lubricants, and has a detergent action on metal parts.

U.S.P. 2,540,533. Sulfonate Grease. J. J. Kolfenbach and R. O'Halloran to Standard Oil Development Company.

A lubricating grease consists of a mineral lubricating oil thickened to grease consistency with 5-20 percent by weight of an oil-soluble metal sulfonate, such as strontium petroleum sulfonate, and 10 percent of a mixture of the lead and calcium salts of an aliphatic carboxylic acid with not more than 6 C atoms. 2.5-7.5 percent of the calcium salt shall be employed for 7.5-2.5 percent of the lead salt.

U.S.P. 2,540,534. Extreme Pressure Grease. J. J. Kolfenbach and R. O'Halloran to Standard Oil Development Company.

The product of this patent is closely related to that of U.S.P. 2,540,533. An alkaline earth metal sulfonate is here employed as a thickener, the sulfonic acid of which has a molecular weight of 300-600. 2-6 percent of an alkaline earth metal sulfonate are added which is prepared from alkyl sulfonic acid of 96-166 molecular weight and 2.5-7.5 percent of an alkaline earth metal salt of an aliphatic corboxylic acid with 1-4 C atoms.

U.S.P. 2,540,570. Extreme Pressure Lubricant. E. B. Cyphers to Standard Oil Development Company.

A mineral lubricating oil composition contains 1-20 percent by weight of an ester of the formula $R—CO—X(CHZ—CHZ'—X)_n—CO—Y$ wherein X is oxygen or sulfur, n is an integer of 1-4, —COY is the combined radical of a rosin acid, R is an unsaturated fatty acid with 11-21 C atoms and Z and Z' are hydrogen, or a paraffin with 1-4 C atoms. This ester is treated in a special manner with sulfur and then with a phosphorous sulfide at elevated temperatures.

U.S.P. 2,540,580. Quality of Olefin Polymer Lubricants. R. L. Heinrich to Standard Oil Development Company.

A mixture of olefins boiling below 450° F. and P or P_2S_5 is contacted with a Friedel-Crafts catalyst at a temperature of 50-250° F. in the liquid phase for 1-3 hours to polymerize the olefins and simultaneously to react them and their polymers with P or P_2S_5. The lubricant obtained has improved stability to oxidation and further polymerization during use.

U.S.P. 2,540,795. Emulsifiable Hydrocarbon Oils. J. E. Schott and E. Laug to Socony-Vacuum Oil Company, Inc.

A hydrocarbon oil contains an addition of 8-25 percent by weight of an oil-in-water emulsifier and 0.3-4 percent of a dibasic alkali-metal orthophosphate. This emulsifiable oil composition has good storage stability and forms stable emulsions even with hard water.

Patents Continued on Page 203

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Improper water conditioning resulting in corrosion, scale, biological fouling or a host of other troubles, is one sure way to pile up high operating costs in any plant. That's why it's so important—and so profitable—to do something about it now!
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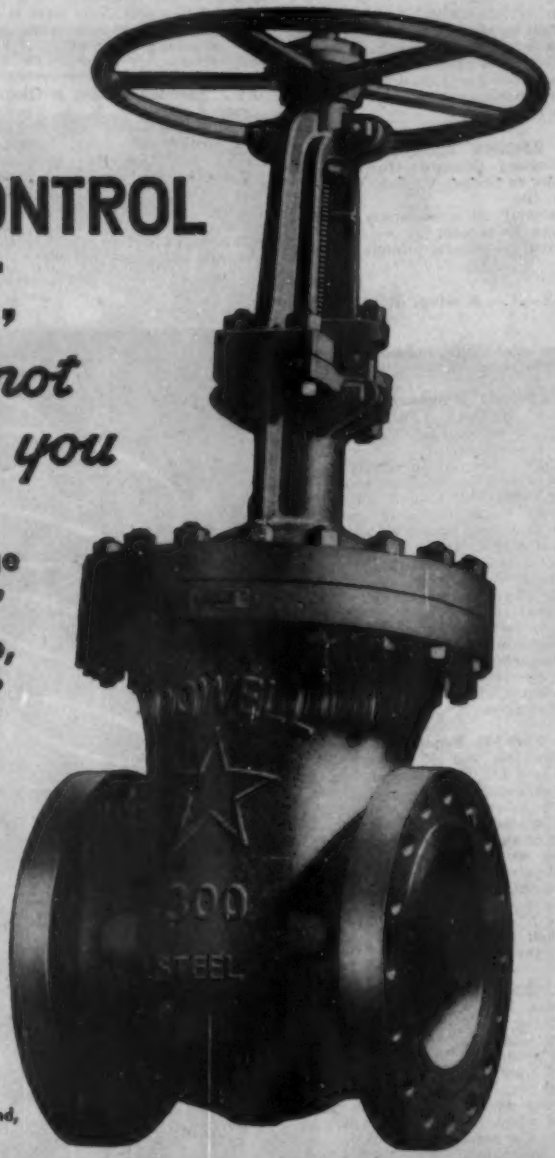

Fig. 3003—Class 300-pound, flanged end, Cast Steel O. S. & Y. Gate Valve.

POWELL

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PETROCHEMICALS

U.S.P. 2,538,722. Diphenylthiophene from Styrene. L. R. Drake to The Dow Chemical Company.

A mixture of styrene and sulfur is precooked by heating at temperatures of 145-150° C. for at least 2 hours and is then heated at 400-600° C. for not more than 60 seconds. After cooling 2,4-diphenylthiophene is recovered from the condensate formed.

U.S.P. 2,538,723. Process for Producing Perchlorethylene. O. Fruhwirth and H. Walla to Donau Chemie A. G.

An intimate mixture of acetylene and chlorine in the volume proportion of 1:3 to 1:3.5 is burnt in the form of a flame having at its cooler end a temperature of 600° C. and at its hottest part a temperature of 750-950° C.

U.S.P. 2,539,341. Preparation of Vinyl Cyclohexene Dichlorohydrins. O. C. W. Allenby and G. F. Harris to Canadian Industries Ltd.

An aqueous solution of H_2SO_4 of 10-20 percent concentration is added at a temperature not over 10° C. to a suspension of one mol 4-vinylcyclohexene in an aqueous solution of 2 mols of NaClO having a hypochlorus acid concentration of 2-4.5 percent by weight. Dichlorohydrins of 4-vinylcyclohexene are formed.

U.S.P. 2,539,668. Production of 1-Fluoro-3,3-Dimethylalkane by Reacting Ethylene, a Tertiary Alkanol and Hydrogen Fluoride. C. B. Linn and L. Schmerling to Universal Oil Products Company.

Ethylene, a tert. alkanol, and HF are reacted at a temperature of —50° C. to 100° C. A 1-fluoro-3,3-dialkylalkane is formed which has 2 C atoms more per molecule than the tert. alkanol charged; e.g. 1-fluoro-3,3-dimethylbutane is obtained with the use of tert. butyl alcohol.

U.S.P. 2,540,088. Saturated Polyfluoro Alicyclic Hydrocarbons and Their Preparation. P. L. Barrick to E. I. du Pont de Nemours & Company.

A mixture of a saturated alicyclic hydrocarbon and tetrafluoroethylene in the mole ratio of 1:1 to 10:1 is heated at a temperature of 75-300° C. in the presence of a peroxide catalyst. Saturated polyfluorohydrocarbons are obtained.

U.S.P. 2,540,126-7. Photochemical Hydrobromination of Olefins. A. E. Lacomblé, D. Harman and W. E. Vaughan to Shell Development Company.

A fraction of liquid 1-olefins of substantially the same C content and having at least 9 C atoms, formed by cracking petroleum wax, is contacted with a solid adsorption agent, such as silica gel, or extracted with a liquid selective solvent, such as liquid SO_2, until the fraction has a light absorption limit of less than 3000 angstrom units, and is then hydrobrominated by reaction with HBr under the action of actinic light F of less than 3000 angstrom wave lengths. The effect of Mu hydrobromination is substantially increased by the pretreatment.

U.S.P. 2,540,519. Apparatus and Process for Continuous Sulfonation of Aromatic Compounds. A. D. Green and E. W. Carrier to Standard Oil Development Company.

Details are claimed of a continuous process for the sulfonation of aromatic hydrocarbons by a sulfonating agent, such as H_2SO_4.

Patents

U.S.P. 2,540,675. Thiophene Chlorination with Iodine Catalyst. C. E. Johnson, H. C. Wohlers and G. M. Wagner to Michigan Chemical Corporation.

Thiophene and gaseous chlorine or sulfuryl chloride are mixed in the presence of a catalytic amount (less than 1×10^{-4} mol per mol of thiophene) of iodine. The molar ratio of the chlorinating agent to thiophene shall be below 2:1. Chlorinated thiophene is produced.

U.S.P. 2,540,787. Production of Benzonitrile. F. A. Klimitas and H. E. Rasmussen to Socony-Vaccum Oil Company, Inc.

In the adiabatic process for producing benzonitrile from toluene and ammonia at a temperature of 800-1250° F. in the presence of a molybdenum oxide catalyst, water is introduced into the adiabatic reaction zone. Improved yields are obtained.

U.S.P. 2,540,788-9. Process for the Production of Benzonitrile. F. A. Klimitas and H. E. Rasmussen to Socony-Vacuum Oil Company, Inc.

The processes according to these patents are related to that of U.S.P. 2,540,-787. The reaction between toluene and ammonia is here effected in the presence of air; a silica-alumina gel in spheriodal shape of particular description or activated carbon is employed as the catalysts.

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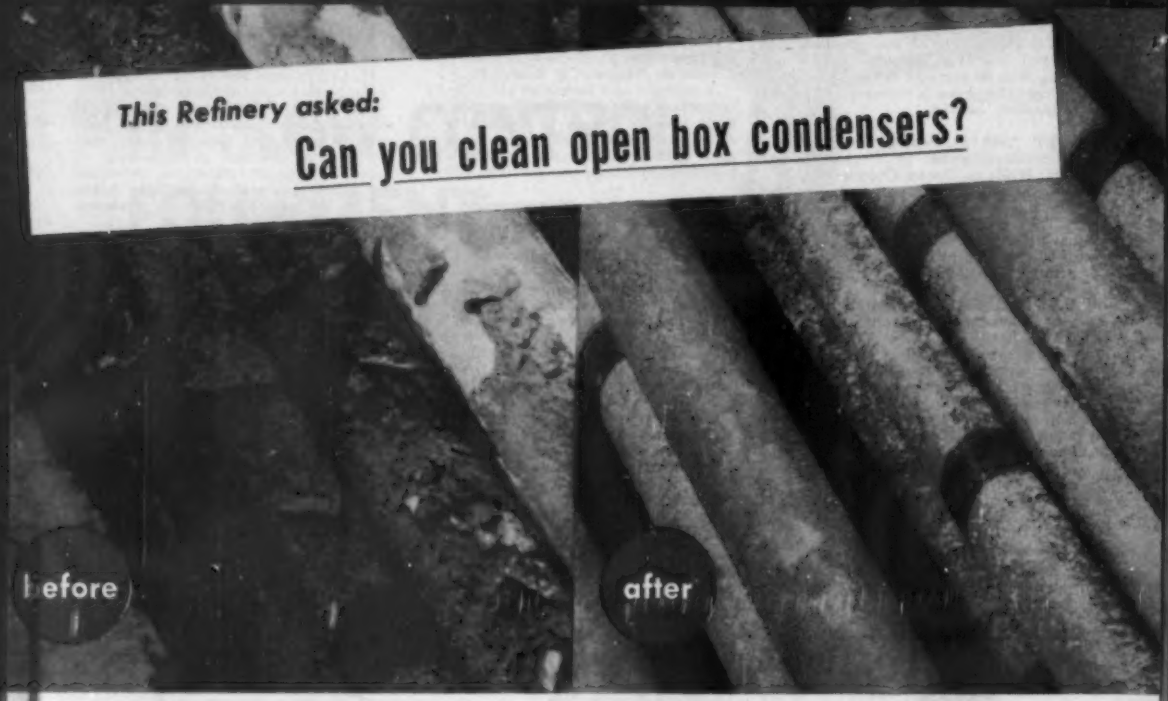

Dowell Service cleaned *THREE* in 10 hours!

A hard calcium carbonate and iron oxide deposit, 1/8 to 1/4 inch thick, had formed on the tubes of three open box condensers in a southwestern refinery. Dowell Service removed an estimated 99% of these profit-stealing deposits, *in just 10 hours.*

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Two comingler condensers in a catalytic cracking plant were cleaned without interrupting operation. Result: Pressure drop across units reduced from 28 lb. to 2 lb.

•

The tubes in four reactor condensers were 85% filled with a wax and oxide deposit, due to unremoved catalyst in the gas oil product. Dowell Service completely cleaned these condensers in 14 hours.

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Heavy ferrous ferrocyanide deposits built up on the trays and caps of the bubble-cap rectifier column in a catalytic cracking unit. Dowell Service removed this deposit in just 27 hours.

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NEW EQUIPMENT and Manufacturers' Literature

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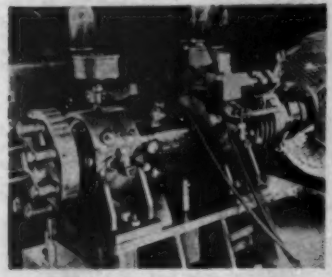
Input Determination

1 Determination of horsepower input of centrifugal pumps has been simplified and made more accurate by means of an electric strain type torquemeter, plus highly accurate speed measuring equipment of a new type and other innovations by Baldwin-Lima-Hamilton, Philadelphia 42. Time and labor of testing pumps are expected



to be cut at least 60 percent in the laboratory of Allis-Chalmers Manufacturing Company where the new equipment is installed. Torque is measured by a Baldwin SR-4 torquemeter, which is based on SR-4 bonded resistance wire strain guages. These gauges are bonded to a reduced section of a special alloy steel shaft at 45 degrees with longitudinal axis. In this position they respond to the maximum torsional strains resulting from applied torque. Gauges are connected to form a Wheatstone bridge by which bending and thrust stresses are cancelled but torsional stresses are made cumulative. These stresses cause proportional bridge unbalance since the resistance of each gauge changes in proportion to the strain on it. The four corners of the bridge are connected through slip rings to a measuring instrument. Torque, drive shaft speed, pump discharge and inlet pressure are all automatically recorded.

Refinery Products

2 A new catalog of refinery products is published by the Mechanical Goods division of United States Rubber Company, Rockefeller Center, New York 20, and contains engineering data on oil, gasoline, liquefied petroleum gas, and the associated products. It also gives data on various types of packing materials and expansion joints, and a section is devoted to the new Uscolite thermoplastic pipe.

Combination Control Valve

3 Annin Valve Company, 3500 Union Pacific Avenue, Los Angeles 23, has developed a valve that combines control valve and a handwheel valve. The combination valve uses the Annin Domotor operator with its powerful direct acting piston mechanism as the control valve. An Annin Handwheel-Valve is mounted on the under side of the single seated valve body. When automatic control is desired the handwheel valve is opened fully causing no complications. During start-ups or instrument repair periods the handwheel provides positive manual control without changing valves. The handwheel may also be used as an adjustable limit stop for the automatic control valve plug.

One Piece Fintubes

4 "Integral One-Piece" Fintubes, Bulletin 511, Brown Fintube Company, Elyria, Ohio, describes the construction of integral extended surface fintubes, lists the range of sizes and the materials in which available, illustrates the wide variety of heating and cooling applications in which they are used, and gives three pages of helpful engineering data, including design curves and a tabulation showing the comparative outside surface areas provided by different sizes of bare pipe or tubing, and longitudinally finned pipe or tubing.

Portable Air Compressor

5 A new type large portable air compressor, announced by Ingersoll-Rand Company, 11 Broadway, New York 4, designated as Gyro-Flow 600, has a rotary compressor, and delivers 600 actual cfm. free air at 100 psi. Total weight is 9500 pounds. The compressor itself is a two-stage, oil-cooled rotating-vane compressor which eliminates pistons, connecting rods, valves, and the need for a clutch. Air is discharged at less than 200° F. under normal operating conditions. This, together with thorough oil separation, eliminates hose deterioration caused by

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section write the manufacturer direct or circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be forthcoming without delay.

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Please have manufacturers send me, without obligation, additional information about items from April, 1951, New Equipment Section whose numbers are circled below:

1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33
34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	

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Company _____

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New Equipment

(For additional information or literature check item numbers on mailing coupon, page 205, or write manufacturer direct.)

heat and oil. The Gyro-Flow 600 is driven by the General Motors Series 71 engine. It is a six-cylinder, two-cycle engine with 12-volt battery starting and a fast-starting ether system for cold weather operation.

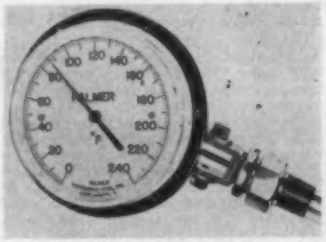
Robomatic Refractometer

6 Automatic control of industrial process streams and batches by measurement of their refractive indexes, hitherto practically impossible, is now feasible with the new Precision-Dow Robomatic Refractometer, manufactured by Brown Division, Station 40, Minneapolis-Honeywell Regulator Company, Wayne and Windrim Avenues, Philadelphia 44. Marketed by the Precision Scientific Company, it provides continuous measurement, recording, and control of the refractive index of a flowing sample from which chemical composition or concentration can be effectively controlled. The Robomatic Refractometer is designed to cover the entire range of refractive indexes from 1.32439 to 1.54409 and provides control over this range to within three parts in the fifth decimal place. Final control may be effected through use of air or electrically operated valves.

Rubber-Lined Valve

7 Developed by R-S Products Corporation, 4600 Germantown Avenue, Philadelphia 44, for emergency gas or liquid shut off service, heavy duty cast iron valve No. 763 is rubber seated. With the angular seating vane for wedge type closure, the rubber is compressed around the periphery of the vane to give positive shutoff even around the shaft bosses. This type of construction makes it possible to use an iron body valve in service that would normally call for stainless steel or other alloy. The rubber flanges take the place of the usual flange gaskets. The valve is completely cycled and operated by a directly connected motor driven pump, sealed in oil. The hydraulic pressure raises the counter-weight for the open position. Should current fail, the oil operator is released, the counter-weight drops and the valve is closed. Valve action can be reversed.

Adjustable Dial Thermometer



8 Palmer Thermometers, Inc., 2501 Norwood Avenue, Cincinnati 12, offers a new development in mercury-actuated dial thermometers. There are three types: rigid stem, wall mounted and flush mounted thermometers. All three types have a full 4½-inch dial face. Construction features include a case, fully compensated for ambient temperatures with a heavy all-glass cover, gasket-sealed to a steel back-plate. It is dust, vapor and water-proof with a durable, non-corrosive finish. The thermometer stem can be adjusted to any angle and the case can be rotated to any readable position.

Welded Pressure Vessels

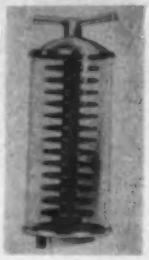
9 American Car and Foundry Company, 30 Church Street, New York 8, has published a pamphlet on "Welded Pressure Vessels" which describes the building of vessels for storage under pressure. Cross section drawings show interior construction.

Combustible Gas Alarm

10 A new sampling type combustible gas alarm system designed to protect from four to eight separate plant locations, with but one installation, is announced by Davis instruments, Division of Davis Emergency Equipment Company, Newark, N. J. The unit embodies the thermocouple principle and indicating or recording devices, and is known as the Davis thermocouple-type indicating or recording tube sampling type combustible gas alarm system. Operation of the unit is based on a timed revolving mechanism, which draws samples through connecting tubes from each of the danger spots into the analyzer where the sample is analyzed, and results are recorded. A complete tour of a four point system is completed every two minutes, while an eight point system requires four minutes for a complete cycle. The system can be used with complete safety where a dangerous concentration of gases or vapors cannot build up to an explosive level faster than the touring cycle of the system, and where the vapor pressure of the combustible is high enough so that no vapors will condense to liquid in the tube lines.

Glass Walled Filter

11 A glass-walled filter to be used where the influent suspensions tend to have variable properties is being produced by Micro Metallic Corporation, 30 Sea Cliff Avenue, Glen Cove, N. Y. Porous stainless steel filter elements of the Surfamax and Gravitain types in glass walled containers permit full observation of the action of the filter. The filter septum is fabricated from porous stainless steel sheet, having a percentage of voids of 50 percent with pore openings of closely controlled size, and in pore sizes ranging between 5 microns (.0002 inch) at the fine end to 165 microns (.0065 inch) at the coarse end. Pyrex glass is used for heat and pressure resistance, and an integral stainless steel guard screen, surrounding the glass body is provided for those applications involving pressures higher than 40 psi. as a protection against the possible hazard of damage due to shattered glass.



Tube Cleaner

12 Bulletin 49 describing the Airetool ball bearing type tube cleaning motor and optional cleaner heads for refinery tube cleaning is available from the Airetool Manufacturing Company, 316 South Center Street, Springfield, Ohio. Illustrated and explained are Airetool's new ball bearing type, Series 6000 air or steam driven motor. Illustrations and data on optional cleaner heads for removing various types of tube deposits are presented.

Resistance Thermometer

13 A new resistance thermometer, designed primarily for determining the average temperature of oil, chemicals, etc., in land storage tanks,

Want More Data?

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side. Or write to manufacturer direct at address shown.

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...for Efficient HEAT EXCHANGE

Always Specify AEROFIN

Aerofin gas-engine jacket-water cooling installation, La Gloria Corporation, Falfurrias, Texas. Designed to cool 334,200 gallons of water per hour from 155° to 145° using 100° ambient air. Heat transfer 27,850,000 BTU/hr. Engineered and built by Hudson Engineering Co.

Whatever the heat-transfer problem — whatever the medium — whatever materials are required for highest efficiency and lowest maintenance costs, you can always rely on Aerofin.

Unequalled experience and production facilities, plus constant research and materials testing, assure the proper construction and design for greatest efficiency and longest service life. ***Ask the Aerofin man.***

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keeping jobs AHEAD OF SCHEDULE is easy with AIRETOOL

Even your least experienced operator can finish rolling a tough tube bundle way ahead of schedule. Refineries now using this new AIRETOOL tube rolling control save valuable hours every time it is put in service.

It's simple to operate. Just insert the ball bearing type expander in the tube to be rolled and when it is perfectly expanded the control automatically shuts off the motor. Expansion guesswork has been eliminated.

CONTROL OFFERS EXCLUSIVE ADVANTAGES

- Permanent calibration... needs no adjustment.
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Get your own tube rolling jobs running ahead of schedule. Find out immediately how this control can help. Write the AIRETOOL MFG. CO., 316 S. Center Street, Springfield, Ohio.

FURNACE TYPE CLEANER

This AIRETOOL Furnace type cleaner with ball-bearing motor and three tier cutter head is just one of our many "timesavers."

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There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction.

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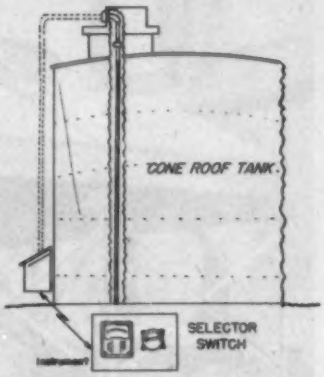

has been introduced by Weston Electrical Instrument Corporation, 641 Frelinghuysen Avenue, Newark 5, N. J. It can be located at either the top of the tank, or the bottom, or even placed in a central control house so that a number of tanks can be connected to meters in one conveniently located station, or installed in existing tanks without taking the tank out of service. The assembly operates on 6 volts d.c. which may be supplied by dry cells, or a 115 volt a.c. circuit by equipping the meter with a transformer and rectifier. Weston Model 918.

Concentric Tubing

14 A new two-fluid-pass heat transfer surface in the form of concentric tubing with radial fins is made by the Industrial Division of Modine Manufacturing Company, Racine, Wis. Modine CRF Tubing can be fabricated of copper, steel, stainless steel, nickel, etc., in lengths to 20 feet, and is suitable for a wide range of temperature and pressure requirements. For maximum heat transfer, intimate contact is accomplished by means of fusion bonding of fin and tube elements. Tubing may be equipped with simple "T" end fittings to provide easy connection to both passes, and can be conveniently arranged in series parallel banks.

Insulating Fire Brick

15 Folder JM-3000: Insulating Fire Brick published by Johns-Manville, 22 East 40th Street, New York 16, presents the economic advantages, industrial applications and refractory properties of this product, an insulating fire brick for sustained use at 300° F. Physical and thermal characteristics are given in table form. An illustrated description highlights the use of these insulating fire brick in the construction of a furnace.

Junction Boxes

16 Heavy-duty weatherproof junction boxes made of non-corrosive, cast aluminum are announced by Stone Manufacturing Company, 489 Henry Street, Elizabeth 4, N. J., and

A FORTUNE At Stake...

. . . . . But Orbit Forged Steel L. P. Gas Valves have everything under control here.

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(serving the Gulf Coast)

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The Orbit Resilient, Friction Free Seating principle is a Natural for holding Liquefied Petroleum Gases. Regardless of minor Body deflections, contractions or expansion brought about by fluctuating temperatures or pressures, the Orbit Seating principle is not affected. You can depend on Orbit Valve in an emergency – play safe when a fortune is at stake.

Our new 1951 Catalog gives full detail on this modern L. P. Gas Valve. Write for a copy.

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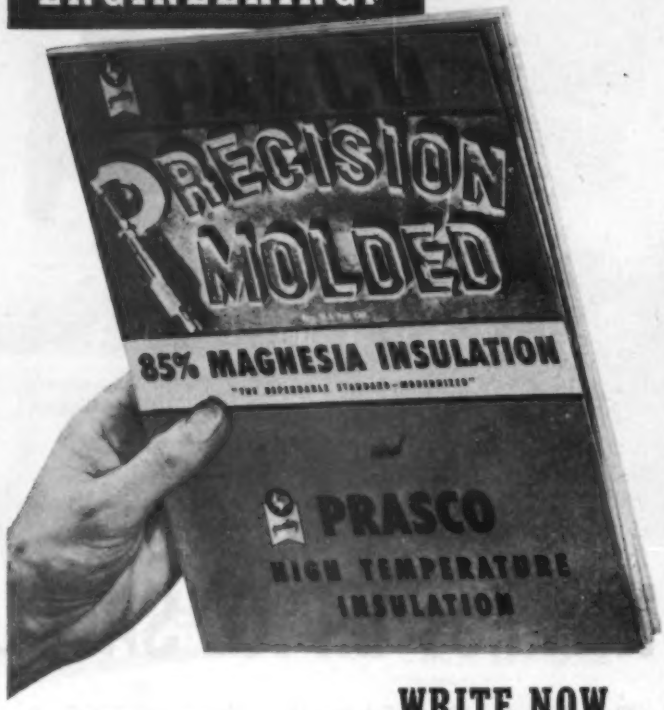
VALUABLE 58 PAGE REFERENCE BOOK ON HEAT INSULATION ENGINEERING!



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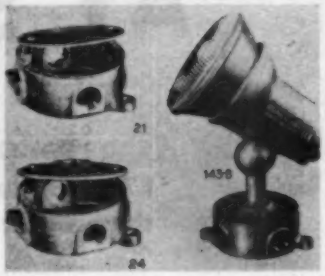


include covers and fittings for universal use on almost any outdoor wiring or lighting job. The box has four hubs tapped one-half inch IPS, is provided with or without mounting lugs, has a flat aluminum cover plate sealed with a heavy cork gasket and a separate cast aluminum cover tapped one-half inch IPS to take standard lamp holders for the 150, 200 and 300 watt outdoor weatherproof reflector bulbs. Used with lamp holders as illustrated, and mounted on walls that form boundary lines, the unit is effective for property-line lighting, for protective floodlighting, etc. UL approved.

Steam Trap

17 Velan Universal steam trap an 8½-pound unit, by Velan Engineering Company, One Exchange Place, Jersey City, "has the same capacity and efficiency of ordinary 2-inch traps weighing up to 200 pounds." Seven different devices are combined together in the small unit: steam trap, air bypass valve, check valve, self-cleaning strainer, flow control glass, temperature indicator gauge, and a temperature control. It can be installed in any position without affecting its efficiency and in the vertical position is said to be frost proof. The valve is opened by steam pressure and closed by thermal action. In super-heated power plants it can handle pressures of 650 psi. and temperatures up to 1000° F. Catalog and specification data.

Controllers

18 Black, Sivalls & Bryson, Inc., Box 1529, Tulsa, have published a new Section 103 for their "Climax" catalog. It introduces a new version of the displacement type liquid level controller to be known as types 887, 888, and 889. The new types replace former types 850, 855 and 850-LB. Revision sheets, a new general index sheet and a table of contents are included.

Pipe Line Coupling

19 The "Weld + Ends Coupling" for rejoining of crude oil, gasoline, L.P. gas and gas pipe lines is manufactured by The E. H. Wachs Company, 1526 North Dayton Street, Chicago 22. The coupling, permits the effective sealing of pipe from 2 to 36 inches in diameter in a matter of minutes. Full pipe line pressure can be re-

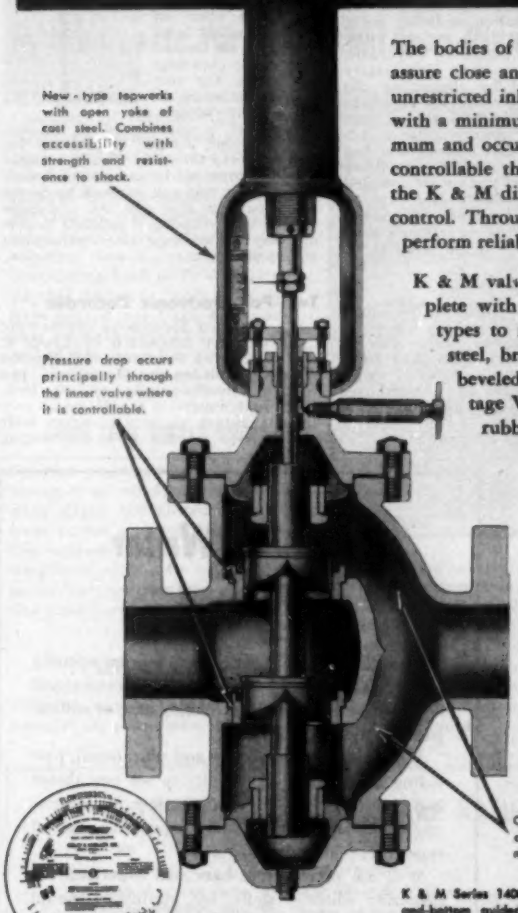
The Control Valves DESIGNED ESPECIALLY FOR INSTRUMENTATION

The bodies of K & M Control Valves are especially designed to assure close and positive control by instrumentation. They have unrestricted inlet and discharge passages and permit smooth flow with a minimum of turbulence. Pressure drop is held to a minimum and occurs principally through the inner valve where it is controllable through the full valve travel. The construction of the K & M diaphragm motors assures extreme precision in this control. Throughout, K & M Control Valves are engineered to perform reliably in *the most exacting applications.*

K & M valves are available in sizes from ½ to 20-inch, complete with diaphragm motor and are made in 13 different types to meet varying requirements. Constructed of semi-steel, bronze, cast steel or special alloys. Inner valves in beveled quick opening, percentage parabolic or percentage V-port design as standard. Facings range from soft rubber to stellite.

New - type topworks with open yoke of cast steel. Combines accessibility with strength and resistance to shock.

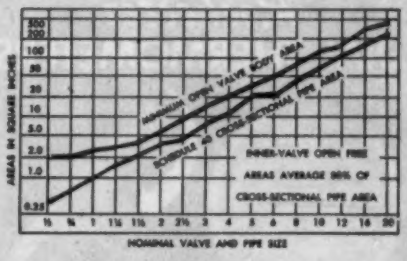
Pressure drop occurs principally through the inner valve where it is controllable.



K & M Series 1400 top-and-bottom guided diaphragm motor valve.

Over-size, streamlined body areas reduce turbulence and friction to a minimum and assure smooth, maximum flow.

Because of their modern design, all K & M valve bodies have extremely high capacities in relation to corresponding pipe size:


AREAS IN SQUARE INCHES
MINIMUM OPEN VALVE BODY AREA
SCHEDULE 40 CROSS-SECTIONAL PIPE AREA
INNER-VALVE OPEN FREE
AREAS AVERAGE 86% OF
CROSS-SECTIONAL PIPE AREA
NOMINAL VALVE AND PIPE SIZE

KIELEY & MUELLER

Established 1879

New Equipment

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stored immediately and welding done after line is back in service. A safety feature of the coupling makes it possible to rejoin high pressure steel pipe lines under hazardous conditions without using a torch, by the use of a mechanical seal with neoprene rings. Used with the company's National pipe saw, the coupling makes it possible to cut a section out of a pipe line and insert a new section without lighting a torch or having an open flame on the job.

Faceshields

20 Faceshields offering choice of specific visors for specific types hazards, have been introduced by Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8. The Chempruf visor is specially built to guard the face, eyes and neck against chemical splash, while the Chipruf visor offers particular protection against light flying particles. The Chipruf visor is particularly recommended for use in sanding, light grinding, wood working, etc. Chempruf visor gives needed protection when acids, oils, chemicals, gasoline or hot liquids may splash or spray. Bulletin CN-4.

Hydraulic Filter

21 A Staynew hydraulic filter, announced by Dollinger Corporation, 11 Centre Park, Rochester 3, N. Y., is designed for use wherever dirty liquids are collected and recirculated. The filter, described in a bulletin, is suited for application on lathes, mills, shapers, planners, drills, conveyors, plastic molding machines, hydraulic presses and on many other. Unnecessary wear is prevented by eliminating the intake of abrasive particles. Spoilage and rejects at the point of use are kept to a minimum by insuring clean liquid. There are three major parts—lower end plate, insert and combined supporting tube and upper end plate with threaded outlet sleeve. The entire unit may be disassembled in 30 seconds, and insert replaced at low cost or cleaned with solvent or brush.

Agitators

22 Bulletin 151, describes the equipment manufactured by Cleveland Mixer Company, 7016 Euclid Avenue, Cleveland 3, Ohio. The pamphlet describes and illustrates 14 items, among them standard agitator turbines, Type S-Top entering agitator, complete mixing kettles, reaction vessels-tanks, ribbon blenders, flocculator, etc.

Vertical Pump

23 The new Type VLT pump, developed by Byron Jackson Company, Box 2017 Terminal Annex, Los Angeles 54, for general industrial applications, incorporates a BJ mechanical seal, which is suited for the handling of petroleum products generally.

It is a small, standard, vertical pump, furnished with pipe tap suction and discharge nozzles, Type U mechanical seal and standard materials. It is built in one-barrel size, in which either an open or closed impeller bowl assembly can be installed. By omitting the barrel, the unit is ideal for sump or tank pump service. The barrel is constructed of six-inch standard pipe, flanged at the top for connection to the nozzle head. A motor flange is provided to receive solid shaft motors from one and one-half hp to ten hp inclusive at 3550 rpm. An adjustable flanged type coupling is supplied to permit easy and accurate lateral adjustment of impellers.

Two-Pen Electronic Recorder

24 Two-pen Speedomax electronic recorder announced by Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, records two function simultaneously against time. Since both functions are drawn as continuous curves on a 9⅞ inches wide chart, users can follow swift-changing

Accidents are bound to happen . . . like dropping or banging a thermometer sufficiently hard to make readings inaccurate. This could result in costly production errors. To eliminate this possibility, Rochester now offers a new bi-metallic Dial Thermometer with screw adjustment permitting recalibration on the job! Simply put the instrument in boiling water or other known temperature and reset indicator. Better order today. Send for Catalog No. IT-650, Rochester Manufacturing Co., Inc., 38 Rockwood St., Rochester 10, N. Y.

ROCHESTER MANUFACTURING COMPANY, INC.
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The PETROLEUM REFINER has an opening on its editorial staff for a chemical or mechanical engineer well-grounded in refining and/or natural gasoline plant operations.

Work is highly interesting and educational, providing an unusual opportunity to see new things and meet people. Besides an engineering degree, applicants should have plant experience. Use of typewriter and camera required.

It is not necessary to have had experience on magazine editorial staffs, but applicants should have written considerable volume of reports and papers—and MUST LIKE TO WRITE.

State: education, age, refining or natural gasoline plant experience, writing experience, and salary expected above traveling expense.

Address applications to: Editorial Director, The PETROLEUM REFINER, Box 2608, Houston 1, Texas.

ALCOA

Published by Aluminum Company of America

Rearmament needs severely limit the manufacture of aluminum heat exchanger tubes. But we realize that the purchase of refinery and processing equipment requires long study of economic and performance factors. That is the reason for this message.

ALUMINUM SAVES 1/3
in tube costs for Sid Richardson Plant

When the Sid Richardson Gasoline Company of Fort Worth, Texas, built their Kermit, Texas, gasoline plant, the Chief Engineer specified Alcoa Aluminum heat exchanger tubes in the eight lean oil—rich oil exchangers. The saving of ⅓ in tube costs over other metals, together with satisfactory experience dating back to 1927 prompted this decision. Service records have proved that Alcoa Aluminum heat exchanger tubes are not attacked by the sulfur compounds present in this process operation.

STEEL TUBE SHEETS USED

Because possibilities of galvanic action in an oil-to-oil exchanger were slight, the aluminum tubes were rolled in steel tube sheets. The greater ductility and light weight of aluminum tubes made further savings over steel tubes for this same service.

SERVICE LIFE

There are now more than 100,000 pounds of aluminum tubes installed in this service, all operating at temperatures of 475°F. and over. The aluminum tubes show no sign of corrosion. Experience in similar installations indicates that the aluminum tubes will last indefinitely in such installations.

ALCOA OFFERS BOOKLET

This 24-page booklet will answer many of your questions about Alcoa tubes. It covers fabrication techniques, alloy selection, chemical and petroleum applications. It describes tube cleaning, inhibitors, cathodic protection. It contains complete information on fluid flow and heat transfer. There are formulas, tables and specification data. Write for your free copy today. ALUMINUM COMPANY OF AMERICA, 1864D Gulf Bldg., Pittsburgh 19, Penna.

THESE APPLICATIONS ARE NATURALS FOR ALUMINUM TUBES:

Petroleum

- Condensers handling hydrocarbon fractions such as gasoline, naphtha, gas, oil, etc.
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- Lube oil coolers
- Natural gas compressor aftercoolers
- TCC overhead condensers
- Recompressor aftercoolers
- Hydrogen sulfide gas coolers
- Furfural condensers and heat exchangers
- Propane chilling
- Wax sweaters
- Lean oil—rich oil exchangers
- Amine solution coolers
- Glycol-amine solution coolers and heat exchangers.

Chemical

- Butanol
- Ethanol
- Ethylene Glycol
- Glycerin
- Hydroabietyl
- Isopropanol
- Methanol
- Phenol
- Propylene Glycol
- Acetaldehyde
- Formaldehyde
- Furfural
- Heptaldehyde
- Acetic acid
- Butyric acid
- Stearic, Palmitic, Maleic Oleic acids
- Naphtha
- Ricinoleic acid
- Acetanilide
- Ammonia
- Hydrogen Cyanide
- Nitric acid (concentrated)
- Pyridine
- Hydrogen Sulfide
- Benzene
- Dichlorobenzene
- Gasoline
- Gelatin
- Hydrogen Peroxide
- Turpentine
- Xylene

Cooling off "Hot-Heads" in a Hurry!

SHOULD normal temperatures rapidly rise to a dangerous point things happen fast around highly inflammable liquids — in fact, too fast for any fire protection system that doesn't go into immediate action! Blaw-Knox Sprinkler and Fog Nozzle Systems do just that. Actuated by rate-of-rise thermostats, they hit the hot spot with a quenching, cooling pattern of water that stops fire in its tracks. And do it with untreated water at normal pressures! Glad to give you a preliminary survey and estimate costs without obligation.

BLAW-KNOX SPRINKLER DIVISION
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829 Beaver Ave., N.S., Pittsburgh 12, Pa.
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variables with ease. Two separate electronically-amplified measuring circuits, two balancing motors, and two recording pens are all housed in one standard case. The instrument can operate controls or alarms. Speed of response for full-scale pen movement is 3, 2, or 1 seconds as specified. Chart speed, the Y or time axis, can be selected in the range of 1 to 1800 inches per hour. To aid in identification, the instrument draws one curve in red ink, the other in black. Index pointers are red and black to correspond.

New Steam Generator

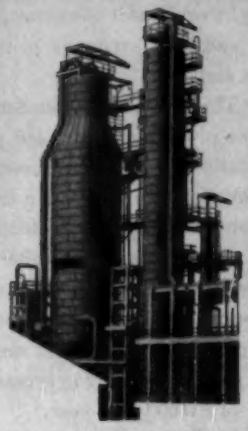
25 A reliable steam plant, (approximately 7 x 5½ x 7 feet), is offered by Combustion Engineering Superheater, Inc., 200 Madison Ave., New York 16. Known as "C-E Recirculation Steam Generator," it is actually a complete steam plant which includes feedwater pump and control, fuel equipment and control, combustion control and safety devices, forced-draft fan, safety valves, circulating pump and all other auxiliaries. The generator may be fired by light or heavy fuel oil or by natural gas. It is available in several sizes for steam capacities from 2800 up to 6000 pounds per hour and for operating pressures up to 300 psig. Distinguishing feature of this small steam generator is the use of the controlled recirculation principle.

Welded Steel Pipe

26 Spang-Chalfant Division of The National Supply Company, 411 Seventh Avenue, Pittsburgh 19, offers Bulletin 370, describing Spang "CW" steel pipe and manufacture. Included are black and galvanized pipe in all standard sizes from ¼ inch to 4 inches, with tables of dimensions, weights, test pressures, threading data, and bundling schedules. It pictures the steps of manufacture from skelp through the heating furnace, the continuous welding process, and numerous finishing operations by which Spang "CW" steel pipe is made.

Flow Regulating Valve

27 Reynolds' flow-regulating valve, made by Reynolds-Shaffer Company, Department 73, 12100 Cloverdale Avenue, Detroit 4, is a de-



Example in Efficiency

...from a problem in petroleum

There's an idea for you in the solution of a petroleum processing problem. It typifies how ingenious engineers and equipment builders can help solve your equipment problems. Involving sour crudes and clad steel equipment, it's particularly significant today when uninterrupted production and materials conservation are so important.

Whether you need old equipment modernized, or new units constructed, progressive equipment builders can contribute to increased production and greater economy, while making the most effective use of scarce metals.

To make certain that users get the greatest benefit from their equipment investment, such equipment builders apply the *Lukenomics* principle. For Lukenomics combines their experience and that of designers and engineers with Lukens' specialized knowledge of materials and their application. For names of equipment builders who can help solve your problem, write Manager of Marketing Service, Lukens Steel Company, 404 Lukens Building, Coatesville, Pa.

With the defense program having first call, you'll understand why Lukens specialty steel products for civilian use are less plentiful than in normal times.

Faced with the problem of low cost flashing of a lube cut at 750° F. to a furfural refining stock, and involving sour base crudes, a leading refinery installed a flash tower of Lukens Stainless-Clad Steel for semi-automatic operation. The design economically assures resistance to thermal shock, protects against elevated-temperature corrosion and provides necessary strength and rigidity. Results: Long on-stream service with continued through-puts of 20,000 bbls/day. Low maintenance. Reduced manpower. Closer approach to universal operation. By using stainless-clad steel, the engineers and equipment builder efficiently assured long equipment life, thus helping conserve important materials. *This is Lukenomics at work.*

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Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process.

In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

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luxe stop cock for use where an exact setting of the regulated flow of water, or liquid, is required. It can be used as a flow regulating valve for jet pumps and spray pumps; as a by-pass valve on boiler feed lines, or any place where a quick-opening, easy operating flow regulating valve or stop cock is needed. Guaranteed not to leak externally, this close fitting valve permits only slightest internal weeping but even with close-fit, plug still turns easily for accurate manual adjustment. Bulletin.

Flexible Ball Joints

28 "Flexible Ball Joints," catalog No. 215 published by Barco Manufacturing Company, Department J-53, 1801 Winnemac Avenue, Chicago 40, describes the joints which basically consist of a short pipe nipple terminating in an enlarged hemispherical section or ball which is housed inside an outer casing between two molded gaskets. This construction permits rotation as well as side flexing of the ball part in any direction up to 40 degrees. The joints are used to overcome piping misalignment, to allow for settling or movement of piping, to guard against vibration or shock, and to permit movement of loading or unloading lines. The company makes 12 styles and 15 sizes, from ¼ inch to 12 inches, with a choice of seven service specifications and six metals for handling temperatures from —50° to 1000° F., pressures from vacuum to as high as 750 psi. steam or 6000 psi. hydraulic.

Instruments in Research

29 The acceleration of research through the use of industrial and related instruments and apparatus is the subject of an 84-page book published by Brown Instruments Division of Minneapolis-Honeywell Regulator Company, 4498 Wayne Avenue, Philadelphia 44. The book describes many types of equipment which, alone or in combination with other apparatus, are being used in research and analytical studies. In addition to being a reference and application guide for researchers and analysts, the book reflects the strides made in the instruments field since World War II. It also emphasizes how industrial instruments are being

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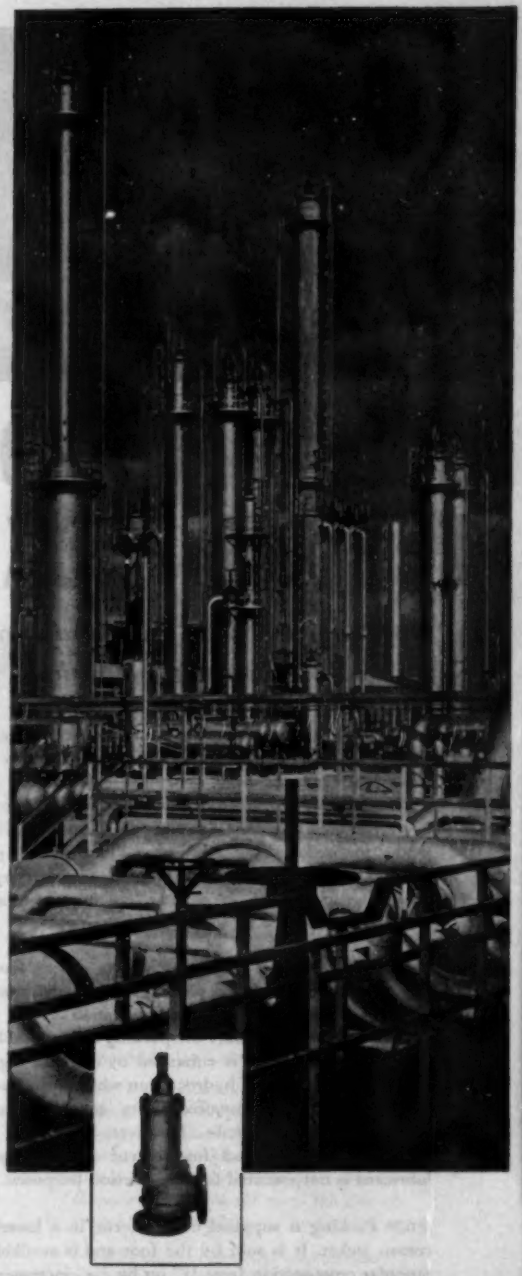

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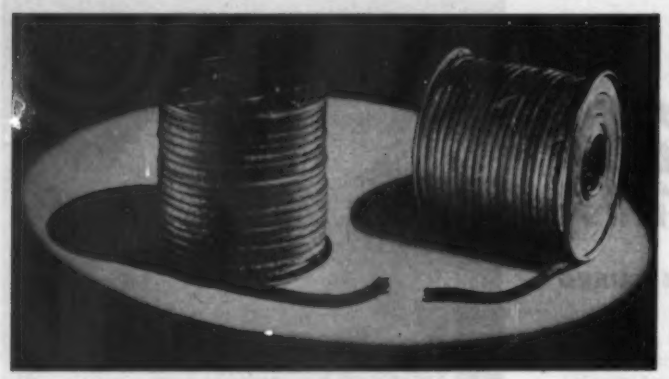

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For valves, pumps, agitators, autoclaves, couplings or any other stuffing box application, Chemiseal #620EG (impregnated with graphite) or #620EM (with mica) extruded Teflon packing is ideal for field maintenance or emergency use where it is impractical to have preformed packing rings made to order. Like all Teflon-"Chemiseal" products, #620EG or EM can't be attacked by *any* organic or inorganic acid, alkali or solvent. #620 is serviceable from −150° F. to 550° F.

"Chemiseal" extruded Teflon packing differs from other shredded oriented Teflon packings in that no synthetic or rubber binders are used in its fabrication—such additives tend to harden and render the packing unserviceable. Lubrication of the packing is enhanced by use of a highly acid-refined, non-nitridable hydrocarbon which, while soluble in common solvents, is unaffected by aqueous solutions of inorganic acids or alkalis. However, Chemiseal #620 is definitely recommended for solvent applications as the lubricant is not essential for anti-friction purposes.

#620 Packing is supplied in coil form, in a loosely-woven cotton jacket. It is sold by the foot and is available in rectangular cross-section from ¼" up by 1/16" increments. Send for Catalog Nos. 620EG and 620EM.

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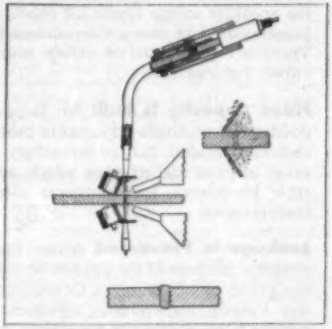
used alone or in combination with others for technical, engineering and laboratory work. Devices, made by many organizations, which are used in combination with Brown instruments are discussed. The "Analytical Apparatus," section details the robotized polarograph titrator and still applications, various types of spectrometers and continuous gas analyzers. "Precision Laboratory Measuring Instruments" includes electronic indicators, the Electrometer, pyrometers for measuring low temperatures and radiation pyrometers for measuring temperatures up to 7000° F. This section also covers high vacuum gauges, and pressure and force transducers. A third section treats converters, balancing motors and servo amplifiers which constitute integral operating parts of research and analytical apparatus.

Welding Process



30 A new process, developed by The Lincoln Electric Company, 12818 Coit Road, Cleveland, extends the advantages of automatic hidden arc welding to jobs where the joint is in positions other than that for downhand welding. This new process consists of new welding methods, procedures and equipment to overcome the difficulties of directing the electrode and retaining flux and molten metal in a joint not lying flat. The plate being welded may be positioned anywhere from flat to vertical, the joint being horizontal. Referred to as "3 o'clock" welding, the process expands the possibilities for the application of hidden arc techniques. Because joints can be positioned horizontally, welds from both sides of the joint can be made simultaneously. Small sizes of electrode wire are used.

Water Softener

31 Cochrane Corporation, Philadelphia 32, has issued Bulletin 4520 on sodium zeolite water softeners, titled "Cochrane Zeolite Softeners featuring the Cochrane Hydromatic Single Control Valve." Explained are the sodium zeolite softening process containing a definition of terms employed in this description, the data necessary for laying out a zeolite water softening plant, the factors governing the sizing of such equipment, the selection of zeo-

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New Equipment

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lite material and a description of both siliceous zeolites and non-silicesous zeolites and a description of the four steps of operation of a zeolite softener. Included is a description of the unique single control valve, the Hydromatic valve.

Hydraulic Hand Truck

32 A new, dual-purpose hand truck with a built-in hydraulic hoist for lifting and stacking is being introduced by Clark-Hopkins Equipment Corporation, Philadelphia 23. This combination hand truck and stacker is of compact, sturdy construction, weighs only 111 pounds and has a capacity of 500 pounds and will lift these loads to tailgate height of 54 inches. The platform is 22 x 19 inches for accommodating larger size packages. The front of the platform is flush with the floor when lowered. Bulletin P-1.

Expansion Joints

33 Yarnall-Waring Company, Mermaid Lane, Philadelphia 18, has available a reprint edition of Yarway Bulletin EJ-1912 on expansion joints containing descriptive literature and details as well as specification information on Gun-Pakt, and Glan-Pakt steel joints. Also available is a bulletin on spray nozzles and a bulletin on Yarway Impulse steam traps.

Curved Insulation Block

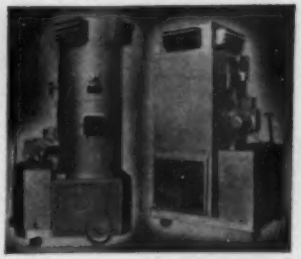
34 Curved block which weighs only 11 pounds per cubic foot is the recent addition to the Kaylo heat insulation line manufactured by Owens-Illinois Glass Company, Box 1035, Toledo 1, Ohio. Range covers tubes and pipes from ¼ inch in diameter to 72 inches and vessels up to 60 feet. Kaylo heat insulation is made of hydrous calcium silicate which insulates effectively up to 1200° F., and is made in all standard sizes of block and in thicknesses from 1 inch to 6 inches for flat surface insulation.

Testing Instruments

35 Refinery Supply Company, 621 East 4th Street, Tulsa, has issued a bulletin listing both R.S. and Ac-Me testing instruments for the petroleum industry. Described are recording gravitometers with or without controller, deadweight gauges, gas gravity balances, high-pressure consistometers, moisture tester for gases, vapor pressure bombs, manometers, Yel-O-Bak thermometers, etc. Bulletin C50.

Portable Heating Unit

36 For heating on construction jobs, and for other temporary applications, the Thermobloc Division of Prat-Daniel Corporation of East Port Chester, Conn., has developed the portable "Thermobloc." It provides a complete heating unit, including fuel tank, mounted on trucks. The unit shown on the left provides 300,000 btu. output, while that on the right is supplied in 100,000 and 200,000 btu. There is also Model 1000 which provides an output of 1 million btu. Information and a bulletin giving heat losses of various building materials and construction design, plus other tables, are available.



Thread Compound

37 A new metallic compound which combines the advantages of a lubricant and sealer to prevent seizure of pipe, bolt and stud threads and gasket faces, has been developed by Armite Laboratories, 6654 Broad Street, Los Angeles. Named Led-Plate, it is recommended by the manufacturers for use at temperatures from minus 350° F. to plus 2900° F. and even higher. Metallic elements, of which more than 70 percent is powdered lead, are held in suspension in hydrocarbons. The compound can be used for steam, gas, water, air, oil, ammonia and various chemical connections. Sample tubes on request.

Pipe Fittings

38 Gruvagrip Fittings, malleable fittings for grooved pipe, including L's, T's, adapter nipples, crosses, laterals, bull plugs and reducers, are made by Gustin-Bacon Manufacturing Company, Kansas City, Mo. The new fittings come in ¾ to 12-inch sizes and withstand the same working pressures as Gruvagrips, the grooved pipe couplings now used in many industrial applications. The fittings are light and are said to be easy to handle and install.

Valve Sizing Charts

39 A steam valve sizing chart by Fischer and Porter Company, Department 3940, Hatboro, Penn., covering the range from 1 to 1 million pounds per hour and a butterfly valve sizing chart covering the range of 15 to 10,000 gallons per minute are now available.

Pneumatic Cylinders

40 Conoflow Corporation, 2100 Arch Street, Philadelphia 3, announces the B-50 Series of pneumatic cylinders for throttling control service. These cylinders, essentially of a new design of "O" ring sealed pneumatic cylinder with a piston positioner in-

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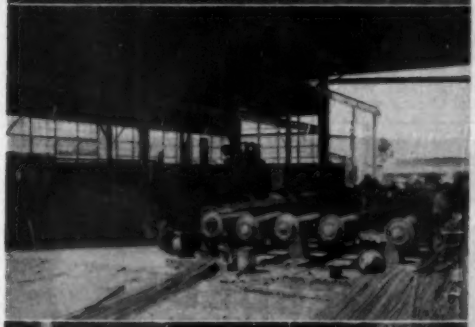

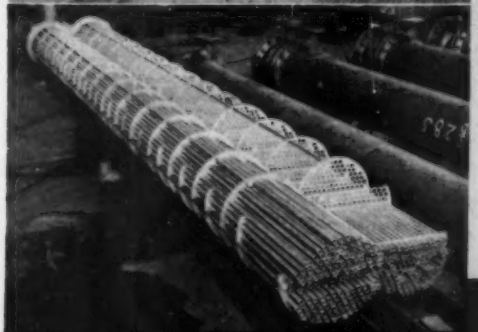

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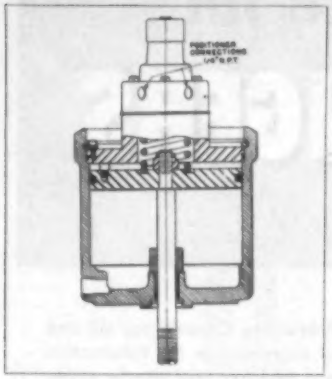

tegrally mounted in the head plate, are a bucket-type made of cast aluminum. The cylinder provides "absolute concentricity of bore and maximum surface smoothness." A one-piece piston is fitted with a graphite-impregnated "O" ring, providing a perfect seal with a minimum of friction. Head plate and piston stem are also "O" ring sealed, eliminating head bolts and gland packing. The positioner is integrally mounted on the head plate, and takes its position by means of a contact spring riding on the piston. The B-50 Series are suitable for use with air supply pressures up to 100 psig and are capable of repositioning accuracies of 1/500th part of the total travel. Bulletin.

Packings and Piston Rings

41 A catalog covering packings and piston rings for industrial service has been released by France Packing Company, Department O, Philadelphia 35. The publication is a comprehensive study of application for all types of packings and piston rings. Special attention is given to new developments in the company's Carbon-Bakelite process, chrome-plated piston rings, and Teflon piston rings.

Blowers

42 A chart booklet on Standardaire Blowers, manufactured by The Standard Stoker Company, Inc., 370 Lexington Avenue, New York 17, contains dimensional information as follows: engineering layout, typical application data, important design data, blower number, ratings-CFM at listed RPM. The information is simplified with schematic drawings illustrating various points and detailed charts.

Mechanical Seals

43 A folder by The Garlock Packing Company, Palmyra, N. Y., describes the company's line of mechanical seals for rotary shafts, which effect sealing by positive contact between lapped metal-to-carbon or metal-to-metal mating surfaces. The booklet gives applications and illustrations of the Garlock package seal (shown), the Chevron-type seal, and the O ring seal.

Vape-Sorber

44 Continuous removal of petroleum vapor from compressed air and other gases by the Vape-Sorber, a newly-developed device, is announced by Selas Corporation of America, Philadelphia 34. Vape-Sorber is installed in air or gas lines to instruments and critical pneumatic operations where "oily air" has detrimental effects. In addition to removing petroleum vapor, the Vape-Sorber removes water, free oil, water-oil emulsions and dirt. Liquid-impervious ceramic filters operate in conjunction with specially compounded activated carbon to deliver clean air-gas to operating equipment, with no moving parts.

Piping Dimensional Data

45 Dimension information on welding fittings and flanges has been condensed and reproduced on two sides of an 8½ x 11-inch card by Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90. One side covers the WeldELL line of Taylor Forge welding fittings. It shows the wall thickness and the essential dimensions for all types of fittings for every nominal pipe size from ⅛ through 30 inches. The other side covers the company's line of forged steel flanges. The essential dimensions and bolting data are given for all types of flanges, in all

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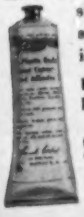

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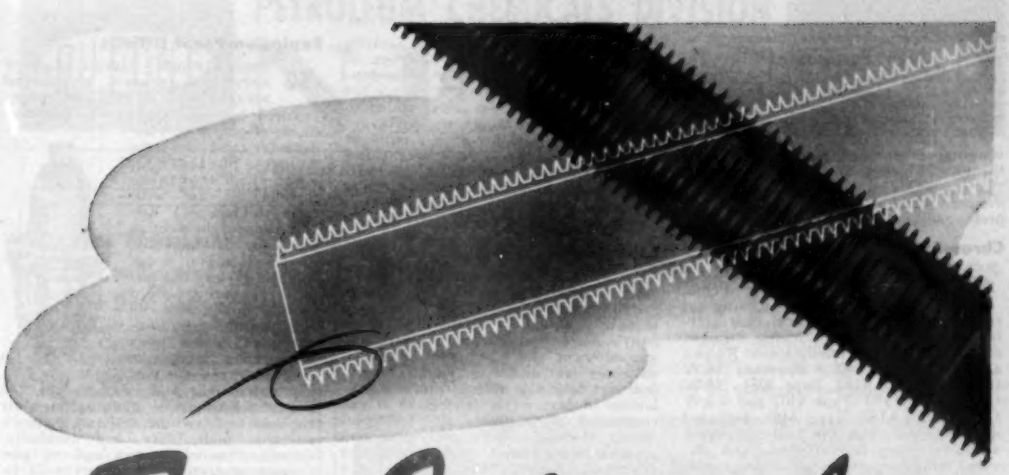

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weights, for nominal pipe sizes from ⅛ through 24 inches. Other useful information for piping engineers is also given on the card which is varnished to withstand prolonged use.

Chromium Steel Tubing

46 The Babcock & Wilcox Tube Company, Beaver Falls, Penn., has published a bulletin outlining the physical and mechanical characteristics of three non-hardening straight chromium stainless tubing steels. Known as bulletin TDC 140, it discusses B&W Croloy 18 Al (AISI Type 405), B&W Croloy 19 (AISI Type 430) and B&W Croloy 27 (AISI Type 446). Included are technical data on analyses, creep strength, properties at room and elevated temperatures, corrosion and oxidation resistance, forging, forming, machining, welding and heat treatment. Bulletin TDC 140.

High Temperature Alloy Guide

47 Two new cobalt-base alloys are described in a revised edition of the booklet, "Haynes Alloys for High-Temperature Service," published by Haynes Stellite Division, Union Carbide and Carbon Corporation, 725 South Lindsay Street, Kokomo, Ind. The booklet contains technical data on ten alloys developed for service at elevated operating temperatures. A section on each alloy describes the material recommended uses, chemical composition, and physical and mechanical properties, in both tabular and graphic form. Graphs compare the mechanical properties of the various Haynes alloys. Age hardening data and fabrication procedures are also included. The two alloys added to the company's line are known as Haynes alloys 25 and 36. Alloy 25 is a wrought material with exceptional mechanical properties at temperatures up to 1800° F. Alloy 36, a comparable cast version of 25, is resistant to oxidizing and reducing atmospheres up to 2100° F.

Telemetering Bulletin

48 A folder on telemetering, Bulletin DM029, published by The Bristol Company, Waterbury, Conn., contains information on the use of the company's Metameter telemeter for remote measurement and automatic control of variables over distances ranging from a few feet to many miles. Typical installations of Metameter telemeters at gas companies, water plants, pipe line companies, electric utilities, processing and manufacturing plants are illustrated and described. Among the applications shown are the remote measurement and control of temperatures, pressures, rates of flow, level of liquids, motion, and various electrical quantities.

Compressors

49 A new catalog, "Centrifugal Multi-Stage Compressors," published by Clark Brothers Company, Inc., Olean, N. Y., contains sections which discuss compressor problems, general features of multi-stage units, recent applications of Clark centrifugals, construction details of their products, describes and illustrates tests to which the equipment has been subjected, and engineering data and performance characteristics.

Explosion-Proof Fittings

50 Explosion-proof fittings, made of corrosion-resistant cast metal sprayed with lacquer, are manufactured by Killark Electric Manufacturing Company, Vandeventer and Easton Avenues, St. Louis 13. Each hub contains threads for use with rigid conduit. (2) Killark vapor-tight fixtures are made of alumalloy, in one-piece and in assembled styles. The latter type consists of a "splice box" with its conduit hub, and a "fixtures cap" which holds a porcelain receptacle. Gaskets make the fitting vapor-tight and weatherproof. (3) Die-cast Fittings of aluminum alloy are said to have rust resistance, tensile strength, malleability, and durability; smooth rounded corners and surfaces provide protection for wire insulation. They are 40 percent lighter in weight than iron fittings.

Steel Fabrication

51 "Beyond Your Blueprints," a catalog released by Nooter Corporation, St. Louis, Mo., provides many useful facts regarding steel and alloy plate fabrication. In addition it explains Nooter's many specialized techniques and services. Also included are corrosion data charts in which are listed the resistance values of commonly used metals with reference to hundreds of chemicals.

High Compression Units

52 A new HBA catalog published by Clark Brothers Company, Inc., Olean, N. Y., covers the company's line of high compression "Big Angle" gas-engine-driven compressors, ranging from 1100 to 22,000 bhp. Models contain 5, 6, 8 or 10 cylinders. Cross section diagrams show details of construction. The new "Super 2-Cycle High Compression HBA" is featured.

Flexible Coupling Catalog

53 Illustrated Folder 2363 on Link-Belt "RC" Roller Chain Flexible Shaft Couplings is offered by Link-Belt Company, 307 North Michigan Avenue, Chicago. Engineering information for proper application includes dimensions, weights, service factors and horsepower ratings. Detailed data on two types of protective grease-retaining casings, Style R (Spun Metal Revolving Type) and Style P (Plastic, Revolving Type), are also included.

Stainless Tubing Data

54 Technical data associated with the design, fabrication and application of stainless tubing is offered by The Babcock & Wilcox Tube Company, Beaver Falls, Pa., in Technical Bulletin 19. It contains data on analyses, oxidation resistance, thermal treatment and mechanical, electrical and physical properties on ten of the most popular austenitic and ferritic stainless tubing steels. Bulletins.

★ NEW Sier-Bath SCREW PUMP

External Gear and Bearing Bracket Type

FOR NON-LUBRICATING LIQUIDS, SEMI-LIQUIDS

Capacities: 1-700 GPM
Discharge: 1000 PSI for viscous liquids
300 PSI for water

★ Greater Dependability
★ Lower Maintenance Costs
★ Longer Life

★ New Single-Point Alignment—eliminates bearing strain and rotor misalignment due to change of position of pump elements. Housings for external timing gears and bearings bolted directly to pump body—thus move with pump body if it is displaced during installation, or if it expands when handling hot liquids.

★ New "Dual-controlled" Rotors—for less wear on bearings and timing gears. Axial control by heavy-duty thrust bearings—radial control by precision cut timing gears and heavy-duty roller bearings.

★ New Speed in Servicing—gear housing center line supported, doweled for accurate alignment. All parts automatically positioned by shoulders and locknuts.

PLUS These Regular Sier-Bath Advantages:

No metallic contact between rotors—sustains high volumetric efficiency.

Only suction pressure on stuffing boxes—reduces packing maintenance.

Less strain on valves and piping—minimum cavitation because pump reduces velocity change. Eliminates hammer, vibration.

Direct-connected up to 1800 RPM, Self-priming, Pulseless Discharge.

Available in horizontal or vertical construction, corrosion resistant alloys. Special bodies, stuffing boxes and bearings for high temperature applications. Sier-Bath "Gearex" Pumps for lower pressures and capacities.

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NORTH BERGEN, N. J.

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DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

April ★ One of a Series of Interest to the Petroleum Industry ★ 1951

Du Pont Antioxidant No. 5 Put to Unusual Use by Steel Company

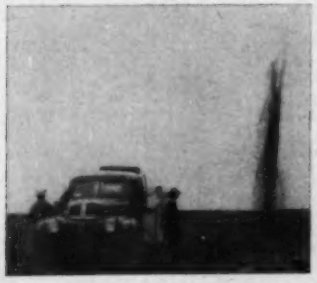
The Kaiser Steel Corporation at Fontana, California has put Du Pont Gasoline Antioxidant No. 5 to an unusual use. This was done in their by-products coke department carbon disulphide tower, which runs secondary light oil from the coking unit.

Previous to the use of Antioxidant No. 5, the tower was shut down periodically about every 3 months for a clean-out because of increased back pressure resulting from a flaky residue in the trays. The first operational run after the Du Pont additive was used lasted 13 months before a shut-down was necessary.

Costwise, the antioxidant addition more or less balanced the direct cost of the more frequent shut-downs. But the inconvenience and the indirect costs of the interrupted operation more than tipped the scales in favor of the inhibitor.

Du Pont Explosives and Know-how Help Locate Oil Deposits

As petroleum men know, wildcatting for oil in an unproved area is no longer as wild a gamble as it used to be. Where once the driller depended chiefly on surface indications and a general knowledge of the local geology, he now seldom starts until he has seen an underground "map" of the area.



Here a seismic shot has just been fired. The explosive used was Du Pont's "Nitramon" S.

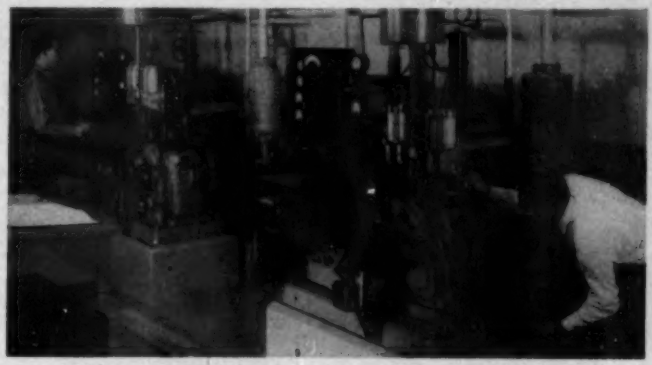
With such a "map" he has a good chance of knowing where salt domes, anticlines, rock faults, limestone reefs and other formations likely to "trap" oil are located.

These sub-surface pictures are made possible through geophysical methods of prospecting, the most widely used of which is seismic prospecting. Charges of explosives, averaging about 15 pounds in weight, are loaded into specially drilled shot holes in the ground. When these are fired, shock waves go out in all directions through the earth. As they meet the various layers of limestone, sandstone, etc., a portion of their energy is reflected back to the surface. Sensitive geophones catch and record these "echoes" on strips of sensitized paper. The developed strips are turned over to technicians who interpret the records and plot the results on maps that show, with remarkable accuracy, where oil may be found. Thus, the use of a few pounds of explosives can often save drilling at a place where there is little or no chance of finding oil.

Representatives of the Explosives Department of Du Pont are well informed on the subject of seismic prospecting. They represent another of the many diversified groups in Du Pont who make their specialized knowledge available to the petroleum industry.

Chicago District Office Organizes One-Day Training Courses For Oil Company Personnel

In keeping with the Petroleum Chemicals Division policy of being of help to refiners in every way possible, Du Pont's Chicago district office has recently organized one-day educational clinics for oil company personnel.



Part of the Chicago District Laboratory showing two ASTM knock test engines in operation.

These clinics tie in with the indoctrination efforts of oil companies located in the Chicago area. Such companies periodically call in various of their personnel for training courses which take them through operations, credit, accounting, research and other departments.

The program offered by Du Pont is flexible. It consists of laboratory talks and demonstrations on Du Pont products, discussions on automotive maintenance, and safe handling practices in connection with TEL and other Du Pont additives.

A typical day's tour of Du Pont's Chicago facilities might start in the laboratory. Here the trainees would receive a thorough explanation of the function of the CFR engine. They would see one or more of these engines in operation.

At this point a slide talk on the motor method and the research method of determining octane numbers of gasoline might be introduced by Dr. A. B. Wilder, laboratory manager.

The response of gasoline to TEL would be described. Also the significance of the various physical tests that are normally applied to gasoline. The physical properties of TEL and other Du Pont additives would also be made clear to the students in the course.

ADVERTISEMENT — Prepared for the Petroleum Chemicals Division of E.I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED Training Courses

Another feature on the program would include a talk by H. E. Cissley who is the Du Pont fleet, bus and tractor expert in the Chicago district. With an impressive background in truck manufacture and maintenance covering many years, Mr. Cissley can be counted on to give an interesting and instructive presentation on the subject of maintenance and other problems concerning automotive equipment.

In the matter of safe handling practices connected with TEL, tank entries, tank cleaning, and hazards having to do with tetraethyl lead in general, Frank Grubb gives a presentation that always proves interesting to his hearers.

At the end of a full and strenuous day, the meetings are brought to a close with a brief portrayal of other Du Pont departments, products and operations.

From this there is invariably one conclusion – the petroleum industry contributes much to Du Pont . . . and Du Pont, with its additives and finishes, its neoprene and nylon, its explosives and chemicals – and its research – in turn contributes much that is of value to the petroleum industry.

Medical Director for Petroleum Chemicals Division

DR. STEWART L. RANKIN is medical director of the Du Pont Petroleum Chemicals Division. He and his associates are at the service of customers at all times to help safeguard the health of employees working with TEL compounds.

Dr. Rankin graduated from Bucknell University with a Bachelor of Science degree in biology in 1926. He then studied at Jefferson Medical College, receiving his M.D. degree in 1930. After a period as an insurance company medical examiner, he became assistant director of Student's Health Service at Lehigh University.

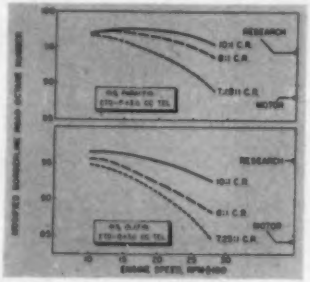
Dr. Rankin joined the medical staff of Du Pont's Chambers Works in 1937. In 1940 he was appointed a physician at the Indiana Ordnance Works, a Du Pont built and operated war plant. He later became medical supervisor at this plant. In 1944 he was made superintendent of the medical department of the TEL plant at Baton Rouge, Louisiana. In 1946 he came to Wilmington.

Road Tests Show Effect of Compression Ratio on Road Octane Rating

To examine the fuel chemical characteristics involved in obtaining maximum road antiknock performance and lead response, Du Pont's Petroleum Laboratory has conducted an extensive series of road tests. These tests were made in cars with engines representative both of today's designs and those of the future. In the program, a total of some 2500 separate road ratings were made on 42 leaded and unleaded gasoline blends.

One of the major conclusions drawn from this work was that in high compression ratio cars, at high speed, the road ratings of the fuels increased markedly with compression ratio, thus making the road octane numbers of fuels more nearly constant throughout the speed range.

Typical examples of the effect of increased compression ratio causing an increase in road octane rating are shown in the graph for two fuels, one containing all paraffins (270-P) and the other all olefins (270-O) in the 270°F.



Typical effect of compression ratio on the borderline ratings of two types of test fuels.

to E.P. fraction. This tendency toward increased road octane rating in the high speed range with increasing compression ratio was consistent with all of the test fuels.

Complete data and results of this project are available in a paper, "The Effect of Hydrocarbon Structure on the Road Antiknock Performance of Motor Fuels."

LITERATURE AVAILABLE

The Petroleum Chemicals Division of Du Pont has published a wide variety of material of interest to the petroleum industry. This includes technical papers, bulletins, reports and memoranda as well as equipment operation bulletins, safety regulations, tank cleaning data, marketing aids and the like.

Any of this is available on request to your nearest Du Pont Petroleum Chemicals Division District Office. A partial listing of available material is shown below:

Blending Calculator for Du Pont TEL Compound (Aviation Mix) . . . . . Serial A-1210

Tank Talk–A 52-page booklet which outlines safe procedure for cleaning gasoline storage tanks. Written for the man who does the cleaning . . . . . Serial A-1134

Du Pont Services to the Petroleum Industry . . . . . Serial A-663

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Petroleum Chemicals

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About EQUIPMENT and SERVICE Suppliers

Dowell Expands Its Office Serving Fort Worth Area

The Fort Worth staff of Dowell Incorporated has been reorganized and expanded with Marshall L. Stirling, formerly of the Tulsa general office, named head at Fort Worth. Roy W. Allen from San Angelo, Texas, and Harold L. Ellis of Odessa, Texas, will go to Fort Worth as sales engineers.

Stirling

Stirling has been with Dowell since 1939, when he joined the firm as sales engineer. In 1946 he was made sales manager of the Petroleum Division. Prior to service with Dowell, he was with the Gas Lift Corporation of Houston, and later with Magnolia Petroleum Company's Natural Gasoline department.

Allen, a Dowell empolye since 1948, served as junior service engineer at Wichita Falls and service engineer at San Angelo before transferring to the expanded Fort Worth office. Ellis, a recent graduate in Chemical Engineering, Texas A. & M. College, has been with Dowell since 1949, serving at Levelland, Texas, Artesia, N. M., and Odessa, Texas.

Herbert A. Koch, former head of the Fort Worth office, has been moved to Houston to establish a general office sales branch. He joined Dowell in 1944 as district engineer in Oklahoma City.

Bingham Pump Adds Three to Sales Force

Bingham Pump Company, Portland, Ore., recently added two men to the St. Louis office, and a third man to the San Francisco office.

Jason Weissenburger, graduate of West Virginia University, will be in charge of Bingham Pump sales on the Inland Waterways, particularly the moving of petroleum by barge and tanker, with headquarters in St. Louis. For 12 years Weissenburger was associated with the Marietta Manufacturing Company, specializing in design and building of barges and tankers for the petroleum industry.

Walter R. Jarrett, graduate of Missouri School of Engineering, is the other appointee to make St. Louis his headquarters. David G. Seabury, assigned San Francisco as headquarters, holds a BE degree in mechanical engineering from the University of Southern California.

Donnelly Promoted by GE

Ralph E. Donnelly of Fitchburg, Mass., has been promoted from assistant to manager of the General Electric Company's Fitchburg turbine sales division. A native of Kansas City, Mo., Donnelly joined the General Electric Company in 1937 as a student engineer on the test course, and later was assigned to the turbine sales division at Lynn, Mass. He rejoined General Electric after naval service in World War II.

Davis to Manage New Catalyst Production Plant in Indiana

C. S. Davis was appointed plant manager of American Cyanamid Company's new Michigan City, Ind., plant, which is scheduled to go into operation June, 1951. The plant will be concerned mainly with the manufacture of microspheroidal type cracking catalysts.

Davis has been general superintendent of the Marietta, Ohio, plant for the past two years. Native of New England and a graduate of Newark College of Engineering he worked approximately six years on synthetic aromatic chemicals and nitrocellulose solutions after graduation in 1926.

By 1932 he was installing sulfuric acid and acid recovery plants for Chemical Construction Corporation in the British

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the only tool of its kind that . .

. . . cuts either standard "taper" or electric "straight" conduit threads by a simple adjustment.

. . . has "radio" dial size-setting. Dies can be removed in a few seconds FROM THE OUTSIDE without use of tools.

. . . is fully-adjustable and easy-working. The only 1 to 2-inch pipe threader that cuts standard, oversize and undersize threads of uniform standard length.

The Beaver 26-R uses one set of dies to thread four sizes—1, 1¼, 1½ and 2-inch. It is fully-adjustable for oversize or undersize threads to compensate for variation in fittings. There's a cam-type universal self-centering chuck, too, which centers the pipe accurately and insures straight pipe lines. Yet, "drip threads" may be cut when desired for heating lines.

Available at all leading supply houses—don't accept substitutes. Competitive in price!

SEND FOR BEAVER CATALOG NO. 51. Address Beaver Pipe Tools, Inc., 252-300 Dana Avenue, Warren, Ohio, U. S. A.

BEAVER PIPE TOOLS

252-300 DANA AVENUE WARREN, OHIO, U. S. A.

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YOU run the risk of tube damage beyond repair every time you rod-out your heat exchanger bundles.

A much safer way . . . a much faster way to descale your heat exchange units it to circulate hot solution of Oakite scale-dissolving compound. No rodding . . . no dismantling.

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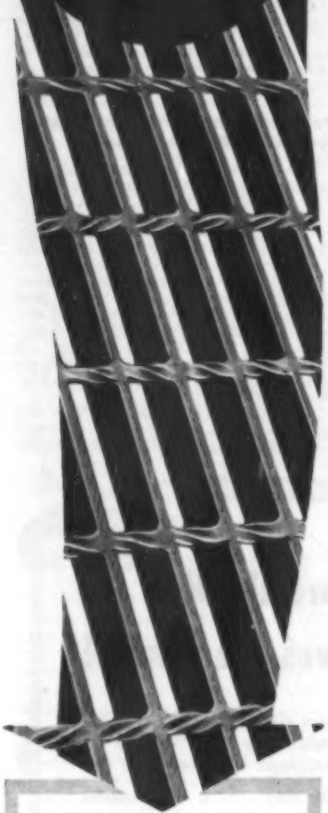

1 Rigid one-piece construction—easy to install.
2 Maximum open area for light and air.
3 Easy to paint — all surfaces accessible.
4 Non-slip Twisted Cross-Bar.
5 Self-cleaning—no sharp corners to clog.

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OF BLAW-KNOX COMPANY
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Offices in Principal Cities

West Indies and on Bahrien Island in the Persian Gulf, later was production superintendent of the Virginia Chemical Corporation plant at Piney River, following which he became general superintendent of American Cyanamid's new titanium dioxide plant at Glouster City, N. J., before being transferred to Marietta.

L. A. Dixon Named Director Of Rockwell Manufacturing

L. A. Dixon, vice president of Rockwell Manufacturing Company's Meter and Valve division since 1948, has been elected a company director. Prior to 1948 he was head of Pittsburgh-DuBoise Company, now a division of Rockwell.

Dixon

Dixon has done considerable field work in the promotion of the company's products for the last 20 years.

Rockwell also announced election of Munro Corbin as controller and I. C. Rowe as secretary. The controller's post was vacated by J. E. Ashman, vice president, who in addition to headquarters office duties, has been placed in charge of the company's power tool divisions.

Corbin has been with Rockwell since 1940 while Rowe, who succeeds E. W. Meyers, retired, joined the company in 1941 as supervisor of taxes.

Worthington Pump Appoints J. J. Llanso as Export Manager

J. J. Llanso, recently appointed general export manager of Worthington Pump and Machinery Corporation, has been a vice president and manager of Worthington Ltd., Buenos Aires, Argentina, since 1947.

Upon graduation from the Massachusetts Institute of Technology with a Bachelor of Science in mechanical engineering degree in 1929, he joined the Worthington student training course. He has been associated with the export department of Worthington ever since, serving 13 years in South America.

DeLaval Promotes Patton

Patrick J. Patton, newly appointed Milwaukee manager for the commercial sales division of DeLaval Steam Turbine Company of Trenton, N. J., will handle the sales of DeLaval turbines, pumps and blowers in Wisconsin. His headquarters will be 1932 North 117th Street, Wauwatosa, Wis.

Prior to joining DeLaval in 1950, Patton was regional sales supervisor for Worthington Pump and Machinery Corporation, and before he was division sales manager for A. O. Smith Corporation.

Dresser Promotes Three

Roots-Connersville Blower Corporation, one of the Dresser Industries, Inc., promoted E. P. Roudebush to works manager, D. A. Johann to sales manager, and A. E. Caudle to assistant sales manager.

Roudebush joined Dresser Industries in 1944 as director of industrial engi-

Whether your cooling tower is new or old—natural or induced draft—let a qualified Fluor Service Representative study your maintenance and repair problems—at no cost to you!

2 FREE SERVICES AVAILABLE

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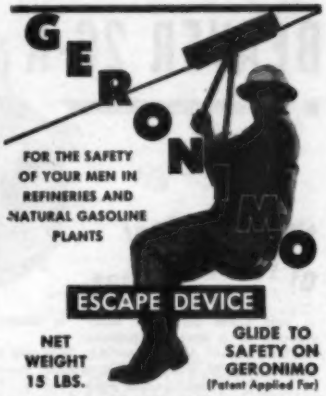
GERONIMO



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GERONIMO will stand hardest wear and give unfailing protection to refinery and derrick man whose lives are endangered by fire, escaping gases or other hazards.

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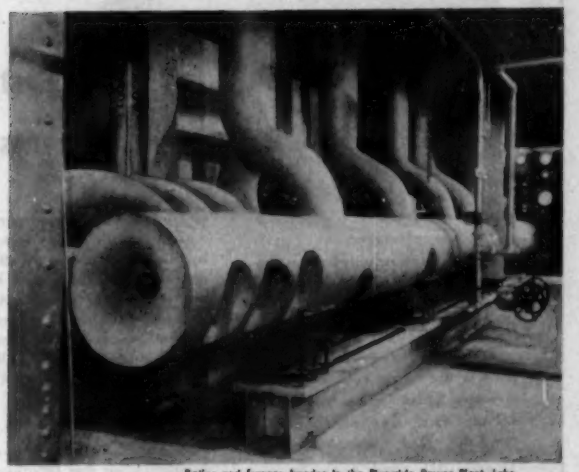

Boiler end furnace header in the Riverside Power Plant, Lake Charles, La., of the Gulf States Utilities Corporation, Beaumont, Texas. **Insulation Contractor:** Armstrong Cork Company.

Whatever your heat insulation problem, you'll find a Keasbey & Mattison covering that will solve it better. Consider the two K&M Insulations used in the above installation, for instance:

"FEATHERWEIGHT®" 85% MAGNESIA

Keasbey&Mattison"Featherweight"85%Magnesia withstands temperatures up to 600° F. without loss of insulating value. It is structurally strong, yet exceptionally light in weight. Alternate heating and cooling, wetting and drying does not effect its insulating properties. Its thermal efficiency remains unaffected after years of service.

HY-TEMP COMBINATION

This efficient and practical insulation combines the high heat-resistant properties of Keasbey & Mattison Hy-Temp with the superior insulating qualities of "Featherweight" 85% Magnesia. This makes Hy-Temp Combination Insulation suitable for exacting temperature control up to 1900° F.

Your Keasbey & Mattison Distributor — who is an experienced applicator — will be glad to give you complete information on these or any K&M insulations. Or, write us direct.

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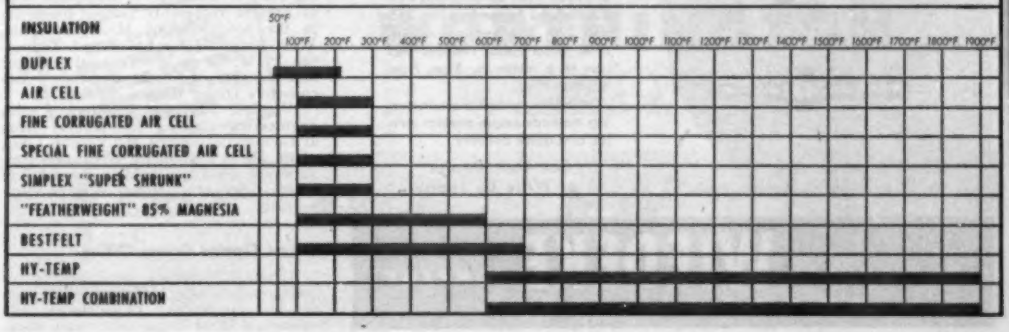

Durametallic Packing Wins Test Sealing 18 Solvents and Diluents

One of the nation's leading valve manufacturers recently conducted a thorough test on the corrosion resistant qualities of three leading brands of packing.

18 solvents and diluents were used in the test as follows: Butyl Acetate, Butyl Cellosolve, Cellosolve, Ethyl Acetate, Bensol Naphtha Med. Boil., Naphtha High Boil., Solvesso No. 2, Toluene, Xylol, Amyl Alcohol, Butyl Alcohol, Ethyl Alcohol, Isopropyl Alcohol, Methanol, Acetone, Methyl Ethyl Ketone and Methyl Isobutyl Ketone.

The packing that proved successful on this 90-day test, (having no leak or corrosion affecting operation), is indicated by the test engineer's report: "A valve suitable for handling solvents, diluents, paint and lacquer thinner should have the following stem packing—DURAMETALLIC NO. 777 NMT."

We will be glad to forward information on this or other types of Durametallic Packings for valve and pump requirements . . . simply write to the Durametallic Corporation, Kalamazoo, Michigan, for Bulletin No. PR-438.

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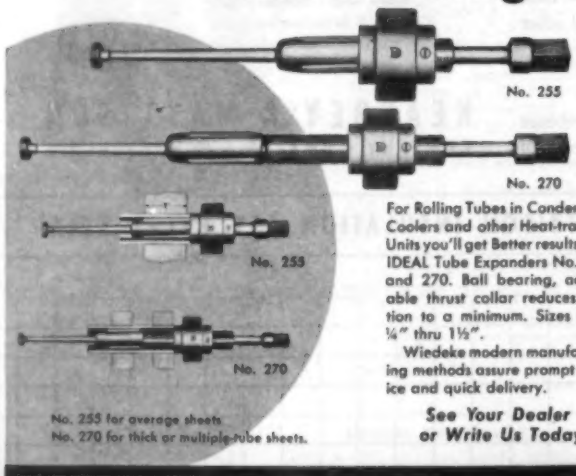

No. 255 for average sheets
No. 270 for thick or multiple-tube sheets.

For Rolling Tubes in Condensers, Coolers and other Heat-transfer Units you'll get Better results with IDEAL Tube Expanders No. 255 and 270. Ball bearing, adjustable thrust collar reduces friction to a minimum. Sizes from ¼" thru 1½".

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neering, transferring to Roots-Connersville in January, 1950, as assistant to the vice-president in charge of manufacturing. Johann joined the organization in 1946 as manager of the Chicago district office, and Caudle in 1946 as chief application engineer.

Gerstacker Joins Colonial

William G. Gerstacker has been named chief engineer of The Colonial Iron Works Company, Cleveland, Ohio.

Gerstacker

Gerstacker received a Bachelor of Science degree in Mechanical engineering from Case Institute of Technology in 1935, and a professional M.E. degree from the same institution in 1943. He has had more than 15 years of experience in metal fabrication industries, having been an engineering estimator with The Pfaudler Company of Rochester, N.Y. and a development mechanical engineer with Union Metal Manufacturing Company of Canton, Ohio, before joining V. D. Anderson Company six years ago. In 1942 Gerstacker was an award winner in the James F. Lincoln Arc Welding Foundation award program.

Francis McCune Is Appointed Manager of GE Engineering

Francis K. McCune, Richland, Wash., has been appointed manager of engineering of General Electric Company's Large Apparatus division in Schnectady, N. Y. He will be succeeded as assistant general manager of the Nucleonics Department by William E. Johnson.

In 1928, soon after getting his degree in electrical engineering from the University of California, McCune joined General Electric as a student engineer on the test course. Subsequently he held positions in the International General Electric Company commercial department and in the West Lynn, (Mass.), Works. He returned to Schenectady in 1946.

Cooper-Bessemer Adds to Staff

The Cooper-Bessemer Corporation, Mt. Vernon, Ohio, has added Grant C. Woodard to its field sales and engineering staff to assist C. J. Michelson who at present represents Cooper-Bessemer in the territories of Michigan, Ohio, West Virginia, Kentucky and Tennessee. F. M. Devin is territorial manager and manager of Cooper-Bessemer's Locomotive Diesel Engine division.

Woodard has been undergoing sales engineering training for several years at Cooper-Bessemer's Mt. Vernon, Ohio, plant. He is a graduate of Cornell University in 1948 and holds a Bachelor of Science degree in administrative engineering.

Arcos Opens Coast Office

Arcos Corporation, manufacturer of stainless, low alloy high tensile and nonferrous electrodes, Philadelphia, has opened a West Coast office and ware-

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exactly the design you need

Worthington has a centrifugal pump for practically any conceivable refinery requirement—in the most complete range of sizes.

The pictures here show only a few of the many purposes served by Worthington Centrifugals. Whether your problem is high temperatures . . . volatile liquids . . . abrasives . . . acids . . . or any of the host of others that harass refineries — the Worthington line includes the one best pump for the job.

Further assurance you enjoy when you standardize on Worthington: you know that Worthington, making the broadest line of pumps, will recommend the best type for each job—you know you'll benefit from *engineering* that's the finest in the business—and you know you can depend on *service* that does its best to keep you in peak production.

Write us for bulletins on the types in which you're interested and see why *there's more worth in Worthington.* Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.

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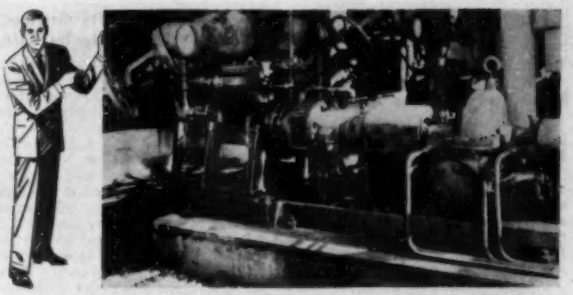
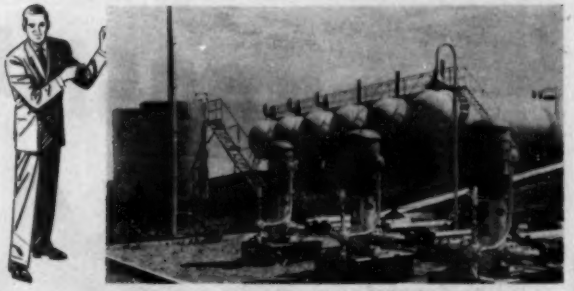
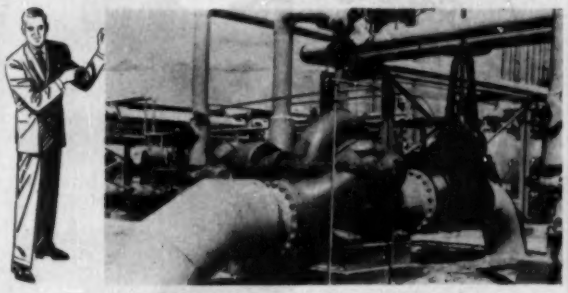


WORTHINGTON HR CENTRIFUGAL, shown at Sun Oil Co., Marcus Hook, Pa., is typical of pumps used in distillation, cracking and treating petroleum products.



WORTHINGTON QBR VERTICAL centrifugal process pump, shown at Magnolia Petroleum Company, Chitwood, Oklahoma, is used to transfer propane, butane and LPG.



WORTHINGTON LA CENTRIFUGAL, turbine-driven, shown at Carthage Corporation plant, Carthage, Texas, is typical of cooling tower and general service pumps.

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

WORTHINGTON

C1.4

Type HR and HB Capacities to 1800 gpm. Heads to 900 ft. Temperatures from far below zero to 800 F. Pressures from high vacuum to 750 lb. gauge.

Type HD Hydraulically-balanced, double-suction impeller handles boiling liquids with low submergence. 600 to 3200 gpm. Heads to 700 ft. Temperatures to 850 F, pressures to 350 lb.

Type CNB for loading or transfer service. Capacities to 1500 gpm. Heads to 500 ft.

Type NM Available in 12 sizes. Capacities to 700 gpm. Heads to 450 ft. Maximum temperature 500 F.

house in Los Angeles. B. E. David has been appointed district manager. This branch office is located at 427 South Western Avenue.

Blaw-Knox Names Anderson

Kenneth W. Anderson has been appointed petroleum engineer of Blaw-Knox Company's Tulsa Office.

A University of Tulsa graduate, Anderson has had 12 years' experience in the design and operation of refinery and gasoline plants. He has also worked on special direct-fired furnace designs for the petroleum and natural gas industries.

Anderson will be assigned to the oil and gas department of the Blaw-Knox Chemical Plants division.

Rockwell Shifts Groom, Munn; Adds Randle to Its Sales Staff

Rockwell Manufacturing Company has announced the transfers of M. F. Groom and R. J. Munn, and the addition of W. A. Randle to its Houston sales staff.

Groom, who has been in charge at New Orleans since joining Rockwell five years ago, will handle in Houston the gas transmission companies and several of the major oil companies.

Munn, in charge of the Corpus Christi office for several years, is also being moved to Houston. Prior to joining Rockwell he worked in the oil fields and also spent a year with the Bethlehem Supply Company.

Randle, who received his B.S. in mechanical engineering from Louisiana State University and his M.S. from the University of Texas, replaces Munn at Corpus Christi.

Worthington Names Fraser Manager for the Midwest Sales

A. William Fraser, formerly General European Manager, has been appointed Midwest sales manager of Worthington Pump and Machinery Corporation. Fraser will direct the sales of Chicago, St. Paul, Kansas City and St. Louis offices, making his headquarters in Chicago.

Fraser

After being graduated from Northeastern University with a degree of Bachelor of Mechanical Engineering, Fraser joined Worthington training course in 1929 and became sales engineer in various Worthington offices and plants. In 1937 he became Chicago district manager and in 1945 general European manager.

H. H. Layritz Awarded 30-Year Service Pin by Lunkenheimer

Harold H. Layritz, sales manager of The Lunkenheimer Company, received his 30-year service pin at a presentation in conjunction with the company's annual international sales convention held recently in Cincinnati.

Layritz was one of seven Lunkenheimer employes honored for continuous service. Perry Cooper, Detroit, and T. J. McGill, Pittsburgh, received recognition for 15 years service; E. F. McAbee, Baltimore, R. C. Forbes and A. F. Stack, Boston, and H. J. Tonkin, New York, were awarded five-year pins.

Representatives at the convention toured Lunkenheimer's two plants for a first-hand look at the modernization and re-tooling program, just completed.

Promotional Transfer Announced For the McCormick by Pacific

Appointment of J. W. McCormick as sales engineer, New York Office, 122 E. 42nd Street, is announced as a promotional transfer.

McCormick entered the service of Pacific Pumps in 1941 following his graduation from the University of Nebraska, serving successively as engineering draftsman, test and field engineer, and application and design engineer. In 1948 he was appointed sales engineer for Pacific Pumps in the Los Angeles-San Francisco districts.

Howell Sent to Washington

Edwin H. Howell, Lynnfield, Mass., is newly appointed special representative of General Electric Company's Apparatus Department in Washington, D. C. Donald E. Craig, Marblehead, Mass., is promoted from assistant to manager of sales of the GE Meter and Instrument divisions to succeed Howell.

As special representative Howell will act as liaison with governmental agencies created in connection with the national defense program, and will co-

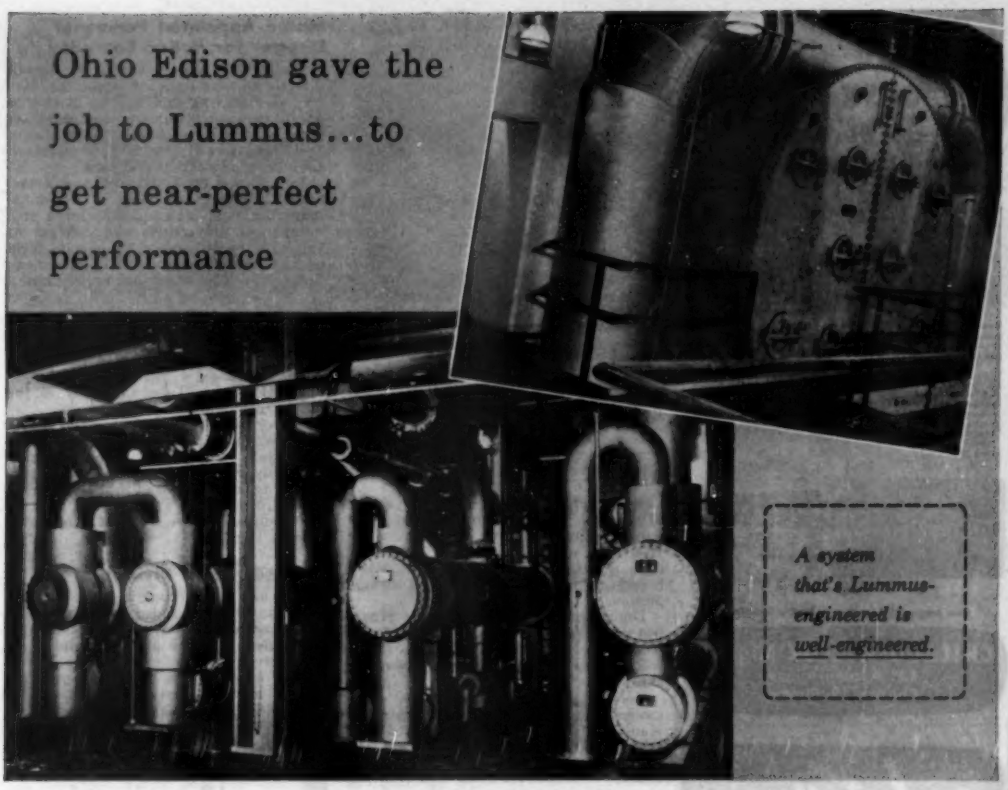
Over years of service these Glucosates have an unexcelled record of satisfactory performance

WRITE ON YOUR LETTERHEAD FOR SPECIAL LITERATURE

D. W. HAERING & CO., INC.

GENERAL OFFICES
P. O. BOX 6037, SAN ANTONIO, TEXAS
CHICAGO OFFICE: 205 West Wacker Drive

Ohio Edison gave the job to Lummus...to get near-perfect performance



A system that's Lummus-engineered is well-engineered.

The surface condenser, feed water heaters, and exchanger shown above are part of a Lummus system installed early in 1944 in the Gorge Power Station of Ohio Edison Company, Akron. Operating records for the intervening years bespeak sound design and fabrication.

The condenser (effective surface of 32,600 sq. ft. to condense 350,000 pounds of steam per hour) has operated over this period without overhauling of shut-down magnitude. Equipped with a deaerating-type hotwell of Lummus design, deaeration has been constant over loads varying from 25% to normal capability of 45,000 kw. Condensate has been tested every shift for oxygen content. Throughout the seven-year run, readings have fallen consistently within what our customers' engineers consider "zero"—a maximum of .005 cc. per liter!

Feed water heaters and exchanger are able running-mates. Heaters were designed for a 7° terminal difference. Routine tests show performance equal to or better than requirements. The two high-pressure heaters to the left employ the Lummus Patented Multilok Closure for channel and floating heads. In seven years of operation, all maintenance has been negligible. Gasket replacement for the Multilok Closure requires only 2-2½ hours on the average for complete turnaround time.

For heat exchanger equipment that gives near-perfect performance, see that *your* next job goes to Lummus. There's an office near you for prompt service.

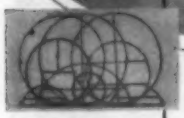
THE LUMMUS COMPANY

HEAT EXCHANGER DIVISION • 385 MADISON AVENUE, NEW YORK 17, N. Y.

Atlanta • Boston • Chicago • Rock Island • Cincinnati • Detroit • Ft. Worth • Houston • Tucson • Salt Lake City • Minneapolis • Pittsburgh • Rochester • Albany • St. Louis • San Francisco • Wayne (Phila.) • Athens • Buenos Aires • Honolulu • London • Manila • Toronto • Paris • Rome • San Juan, P. R. • Mexico City

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers.

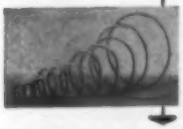
CHICAGO-WILCOX
GASKETS
Proved in Service in the Refinery Industry



GASKETS FOR HEAT EXCHANGERS, COOLERS AND CONDENSERS

Gaskets cut from solid metal, sheet-packing, or double jacket type as needed.

Corrugated metal gaskets for refinery use. Made of ingot iron, Terne-plate, aluminum, stainless steel and monel in sizes from 1 inch up.



A.P.I. ring gaskets for high pressure lines for use on ring-type flanged joints. Made of soft iron and all standard steel alloys in oval and octagonal shapes.

See page 252 in the Refinery Catalog.

CHICAGO-WILCOX Mfg. Co.
7703 Avalon Avenue
Chicago 19, Illinois

Whiton SOLID STEEL ROTOR
STEAM
TURBINES

WHITON LABYRINTH SHAFT SEAL . . . SINCE 1911

Whiton Turbines in service 25 years without seal replacement

Because:

- Factory run-in assures perfect seal and minimum wear.
- Labyrinth seals do not contact shaft, eliminating wear and seizing.
- Steam ejector feature positively prevents steam leakage at outer end of shaft seal.

Write for complete details.

Whiton 1856
WHITON MACHINE COMPANY
New London 14, Conn., U.S.A.

ordinate his activities with E. E. Potter, GE vice president, Washington.

Howell joined General Electric as a student engineer on the test course in 1922.

Cornell

Rigby

A. O. Smith Assigns Rigby As Houston Group Executive

Among executive assignments recently announced by the A. O. Smith Corporation were those of C. R. Rigby, F. B. Dunn, and F. S. Cornell.

Rigby was a group executive at the Milwaukee headquarters but has been named group executive in charge of the Houston plant. This plant manufactures pressure vessels, liquefied petroleum gas systems and vertical turbine pumps.

Dunn, former manager of the Houston works, was placed in charge of personnel for Houston and the entire southwest district of eight southwestern states.

Cornell, formerly manager at Kankakee, Ill., group executive for the Kankakee Works, the Eastern Motor Division at Tipp City, Ohio, and the heating division in Toledo, will headquarter in Kankakee as he will continue to manage that plant for the present.

Conoflow Appoints J. R. Simpson As Its Chicago Representative

Conoflow Corporation, Philadelphia, has appointed J. R. Simpson and Company, 600 South Michigan Avenue, Chicago, as Conoflow representatives.

In addition to the Chicago area, J. R. Simpson and Company headed by J. Robert Simpson, Jr., will operate in Illinois, Indiana, and Wisconsin, where it will be engaged in the application, engineering, and selling of Conoflow control equipment.

For many years Simpson was associated with a major instrument company in a similar capacity.

Shand & Jurs Addition Provides Plant-Office Space

Shand & Jurs Company has announced opening of a new two-story addition that will provide approximately 12,000 feet of additional floor space to its Berkeley, Calif., plant and home offices. All manufacturing activity is carried on at this site although the company maintains offices in Seattle, Vancouver, Montreal, Caracas and Buenos Aires. Horton Steel Works, Ltd., Fort Erie, Ontario, was recently appointed manufacturing licensee in Canada, while Whessoe Ltd., Darlington, England, is licensed in the Sterling Area. The company manufactures and supplies safety, storage and measuring equipment to the petroleum and chemical industries.

Mason Appointed Personnel Director for McKee Company

Walter C. Mason has been named director of personnel for Arthur G. McKee & Company and will be in charge of all personnel and employe relations with headquarters in Cleveland. Mason previously served The E. F. Hauserman Company, as personnel director

In addition to being an experienced administrator in the field of personnel administration, Mason has lectured at a number of universities and colleges at this time he is serving his second term as national president of The American Society for Personnel Administration.

Babcock & Wilcox Tube Names Jones Sales Agent

David W. Jones, Jr. of Denver, has been named sales agent for The Babcock & Wilcox Tube Company in the Rocky Mountain area.

Since 1949 Jones has been sales representative in that area for a number of steel and steel product manufacturing concerns. Before the war he was in the sales department of Carnegie Illinois Steel Corporation.

Headquarters are at 2600 Forest avenue in Denver.

Expands Valve Division

Minneapolis-Honeywell Regulator Company has expanded the engineering personnel and departmental facilities of its Valve division at Philadelphia by 400 percent.

The expansion is part of a program which includes research into and development of new industrial valve de-

anti-corrosive
strapping and seals

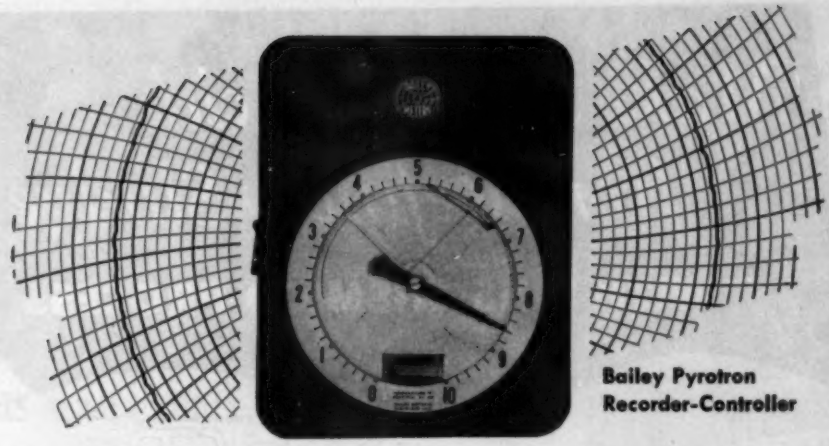
Our specialized service will supply just what you need for securing insulation to forms, pipe lines and tanks. Strapping and Seals produced in

MONEL
STAINLESS, TYPES 304, 316
ALUMINUM
COPPER
BRASS
GALVANIZED

Strapping Tools for applying.

FREE
Handy calculator—one side tells you which strap to use for any given corrosive condition; other side determines length and weight of strap required for any binding operation.

A. J. Gerrard & Co.
1956 Hawthorne Ct., Melrose Park, Ill.
(Chicago Suburb)
SM-2



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

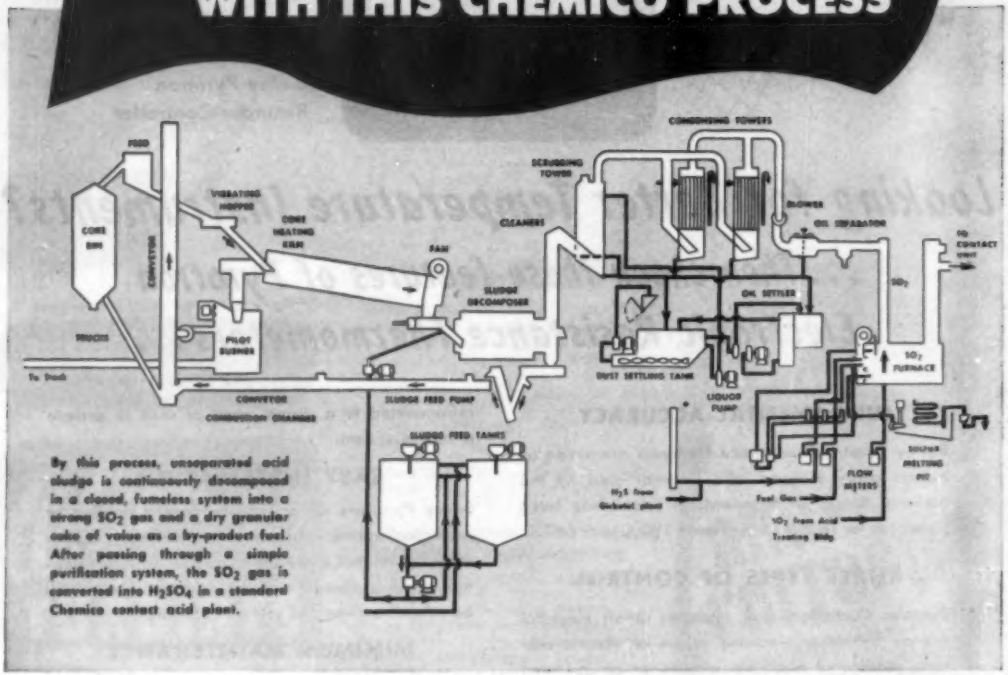
1043 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

Make Sulfuric Acid from Refinery Sludge

WITH THIS CHEMICO PROCESS


CONDENSING TOWERS
SCRUBBING TOWER
BLOWER
CLEANERS
OIL SEPARATOR
FAN
SLUDGE DECOMPOSER
OIL SETTLER
DUST SETTLING TANK
LIQUID PUMP
SLUDGE FEED PUMP
SLUDGE FEED TANKS
CONVEYOR
COMBUSTION CHAMBER
By this process, unseparated acid sludge is continuously decomposed in a closed, fumeless system into a strong SO_2 gas and a dry granular coke of value as a by-product fuel. After passing through a simple purification system, the SO_2 gas is converted into H_2SO_4 in a standard Chemico contact acid plant.

With the increasing shortage of raw sulfur, industry is turning to other materials which can be used for making much-needed sulfuric acid. An important source—waste oil refinery sludge—can be converted into clean sulfuric acid of any desired strength by the Chemico process shown in the flow diagram.

This proved and practical process offers three important advantages. (1) The purified SO_2 gas provides a product acid that is free of carbon contamination. (2) The resulting H_2SO_4 may be 98% or any higher strength regardless of the initial strength of the sludge. (3) Sludges that cannot be processed by other methods may be satisfactorily used in this system.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

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EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
CABLES: CHEMICONST, NEW YORK

Chemico plants are profitable investments

let THIS Remind YOU!

That WEATHERCOAT—

- TROWELS EASILY
- STAYS FLEXIBLE & TOUGH
- STAYS SEALED

Laykold

WEATHERCOAT PROTECTS

the insulation on your hot or cold vessels — for YEARS!

Specified by Leading Refineries for over 15 Years.

Also Try —

MASTIC WEATHERCOAT —
New and ready-mixed for void-filling scratch coat.

Ask for specifications and data.

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Washington 6, D. C. · Baltimore 3, Md. · Perth Amboy, N. J. · Columbus 15, O. · St. Louis 17, Mo. Baton Rouge 2, La. · E. Providence 14, R. I. San Juan 23, Puerto Rico · Mobile, Ala.

In the West
STANCAL ASPHALT & BITUMULS COMPANY
200 BUSH STREET · SAN FRANCISCO 4, CALIF.
Los Angeles, Calif. · Oakland 1, Calif. Portland 4, Ore. · Seattle, Wash. · Tucson, Ariz.

signs, for developing applications for new and existing products, and for speeding production and deliveries Emanuel Wolff, in charge of the division's engineering announced.

Gas Products Sales Supervisor Appointed

M. J. Harper, New York district manager for Rockwell Manufacturing Company has appointed D. L. Jerman as district supervisor of gas products and Nordstrom valves used in the gas industry.

Jerman

Jerman joined Rockwell Manufacturing Company as a sales engineer in 1937 after receiving his education at Dean Academy and Columbia University. He has had wide practical experience in the field of gas and chemical process engineering.

Petro-Chem Promotes Wasp

Petro-Chem Development Company, 120 East 41st Street, New York City, has announced the appointment of Edward J. Wasp as chief process engineer of the company's sales division.

Wasp

He will head the technical sales-engineering department for Petro-Chem Iso-Flow furnaces, officials said in the announcement.

Wasp has devoted the last six years to heat transfer, process problems and furnace designing for the petroleum and chemical industries.

Named Vice Presidents

Johns-Manville Corporation has appointed William R. Wilkinson, vice president for sales, and Kenneth W. Huffine, vice president for production.

Wilkinson, general merchandise manager of the building products division for the past five years, has had 26 years experience with the company. He succeeds L. M. Cassidy.

Huffine, also 26 years with Johns-Manville, succeeds A. R. Fisher who was appointed president.

Additive Division Head

J. E. Kline, in charge of engineering sales of lubricating oil additives for Standard Oil Company (Indiana), has been named head of the Stan-Add Additive division of that company's Sales Technical Service department.

Expands Valve Division Staff

Minneapolis-Honeywell Regulator Company has expanded the engineering personnel and departmental facilities of its Valve Division at Philadelphia by 400 percent. Emanuel Wolff, in charge of the division's engineering, said, the expan-

PYREX sight glasses
BRAND
are most dependable

To see what you're doing, always insist upon Pyrex brand sight glasses!

Here is a glass that is compounded to give you high resistance to acids and thermal shock plus complete visibility over long periods.

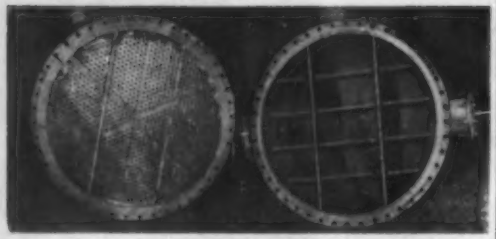
Whatever you operate—ovens, furnaces, stills, evaporators, reactors, pressure kettles, etc.—you need the EXTRA VALUE that is afforded by Pyrex brand Sight Glasses. Available through your Industrial Supply Distributor.

CORNING GLASS WORKS
CORNING, N. Y.

PYREX T.M. REG. U.S. PAT. OFF.

Gauge Glasses, Sight Glasses, Oil Cup and Lubricator Cup Glassware.

• 100 Years of Making Glass Better and More Useful •



Superior Condenser and Head

Built by SUPERIOR for SUPERIOR Operation!

All Superior equipment is designed to do the tough jobs—efficiently. The industry knows of Superior ruggedness, as well as the skill and attention that goes into each piece of Superior equipment. For Superior results—call SUPERIOR.

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FRACTIONATING TOWERS • HEAT EXCHANGERS • SCRUBBERS AND RETUBING OF HEAT EXCHANGERS

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For Estimates Call Amarillo 3-4395

SUPERIOR MANUFACTURING COMPANY
AMARILLO, TEXAS

VOLUMETRIC AND PHASE BEHAVIOR OF HYDROCARBONS

by

BRUCE H. SAGE and WILLIAM N. LACEY

This standard reference work, reporting investigations of the authors closely related with Research Project 37 of the American Petroleum Institute, first published in 1939 and out-of-print for some two years, is again available.

The author's announced purpose for the volume, "to set out for consideration the fundamental principles and some of the facts relating to that type of hydrocarbon behavior which does not involve chemical reactions or changes in the molecular species present," indicates rather accurately the principal contents.

Chapter headings of the book include: Introduction; Mathematical Concepts; Behavior of Pure Substances; Two-Component Systems; Three Component Systems; Multi-Component Systems; The Phase Rule; Partial Quantities; and Ideal Solutions.

Over 300 pages *5½" x 8½"* *Price $5.00*

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P. O. Box 2608
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IS VACUUM THAT'S 99.99% PERFECT good enough for your process?

THIS degree of vacuum is easily obtained with the Croll-Reynolds four or five-stage steam jet EVACTOR, with no moving parts. Each stage from a technical standpoint is as simple as the valve that turns it on. Numerous four-stage units are maintaining industrial vacuum down to 0.2 mm. and less, and many thousands of one, two and three-stage units are maintaining vacuum for intermediate industrial requirements on practically all types of processing equipment.

By permitting water, aqueous solutions or any volatile liquid to evaporate under high vacuum and without heat from an outside source, enough BTU's can be removed to chill the liquid down to 32° F., or even lower in the case of solutions. This is the principle of the Croll-Reynolds "Chill-Vactor." Hundreds of these have been installed throughout the United States and in several foreign countries.

An engineering staff of many years experience has specialized on this type of equipment and is at your service. Why not write today, outlining *your* vacuum problem?

C-R REYNOLDS

CROLL-REYNOLDS CO., INC.
17 JOHN STREET, NEW YORK 38, N. Y.
Chill-Vactors Steam Jet Evactors Condensing Equipment

sion is part of a program which includes research into and development of new industrial valve designs, for developing applications for new and existing products, and for speeding production and deliveries.

Dr. Kitzmiller Promotion Is Announced by Ethyl

Dr. Karl V. Kitzmiller has been appointed associate medical director of Ethyl Corporation. He will direct the medical work of the corporation and act in a supervisory and advisory capacity on medical problems of the sales, research and manufacturing departments, relieving Dr. Robert A. Kehoe, medical director, of all duties possible in Ethyl's health and safety operations.

Kitzmiller

Dr. Kitzmiller joined Ethyl's medical department in 1926, was named medical supervisor in 1942 and assistant medical director in 1946.

Luse-Stevenson Appointed Owens-Illinois Representative

Luse-Stevenson Company, Chicago, has been appointed distributor-applicator for Kaylo Heat Insulation by Owens-Illinois Glass Company in the Chicago area. The Kaylo line of heat insulation includes heat insulating block for flat surfaces, pipe coverings for pipes and tubes from ¼ inch to 72 inches in diameter and vessels up to 60 feet in diameter.

J. R. Winch, Lubrizol, Dies

J. Russell Winch, 59, personnel and public relations director of the Lubrizol Corporation, died March 14 in Cleveland, Ohio.

Winch was associated with Lubrizol for 20 years, serving in sales, personnel and public relations departments. He was a member of the National Petroleum Association, the Society of Automotive Engineers, and the Cleveland Personnel Association.

Foxboro Opens in Knoxville

A new branch office of The Foxboro Company has been opened at 618 West Church Avenue, Knoxville 16, Tenn. Marvin L. Cleaton, Jr., formerly in charge of the office at Columbus, Ohio, has been transferred to become branch manager at Knoxville. Until now, manufacturers in the Knoxville area have been served by the Foxboro office in Atlanta.

Harrell Joins Jefferson

Bryant E. Harrell has joined the Market Development division of Jefferson Chemical Company, Inc., New York. Harrell recently received his Ph.D. degree from The Johns Hopkins University.

Arcos Gets Chicago Office

Arcos Corporation, welding electrode manufacturer of Philadelphia, announced Walter Gordon List had been appointed district manager of a sales office and warehouse to be opened in Chicago. He was formerly special field engineer in the Ohio-Western Pennsylvania territory. The Arcos staff in the Chicago area, headed by List, will supply technical and procurement help on the company's line of stainless, low alloy and non-ferrous electrodes.

PETROLEUM REFINER CLASSIFIED ADS

RATES for Classified Ads are $5 per column inch. Minimum size one column inch. In smallest type size, figure 50 words per inch. Situations Wanted $4 per column inch. **All classified ads payable in advance.** Ten percent discount if three or more insertions are ordered at same time. COPY DEADLINE is 25th of month preceding date of issue. Send copy and checks to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

SHIFT SUPERVISOR: Responsible for supervision of Catalytic Cracking and Poly Plant operations, plus general supervision over process workers during shift. Must be experienced and thoroughly familiar with all phases of refinery operation. Location—Artesia, New Mexico. Write New Mexico Asphalt & Refining Company, Artesia, New Mexico, giving full particulars of qualifications, experience and references.

Named Representatives

Warriner Equipment Company, 504 Delta Building, New Orleans, has been appointed district representatives for both the Northern Equipment division, Continental Foundry & Machine Company, Erie, Pa., and the Vulcan Soot Blower division of Continental which is located in Du Bois, Pa.

Colorado Fuel & Iron Moves

Executive offices of the Colorado Fuel and Iron Corporation and the New York sales offices of the Wickwire Spencer Steel Division have been moved to 575 Madison Avenue, New York 22. The new address became effective last month.

Heating Seminar in May

Second annual John Zink Process Heating Seminar will be held at the John Zink Company plant, 4401 South Peoria, Tulsa, on Saturday, May 26.

The company anticipates that more than 300 engineers from the process industries of the United States, Canada and Mexico will attend. Invitations to attend may be had from the John Zink Company, P. O. Box 7216 Brookside Station, Tulsa 5.

Leslie E. Sebald Dies

Leslie E. Sebald, of the Griscom-Russell Company, died suddenly on March 5. He had been with the company since March, 1919, becoming chief engineer in 1939, and vice president of engineering in July, 1949.

Oscar W. Heimberger will continue as chief engineer, a position he has held since 1949. He has been employed by the company since 1923 and is a 1920 graduate of Ohio State University.

Get Both in One Valve
Automatic and Manual Control

ROCKWELL BUTTERFLY VALVES

For control and quick shut-off of air, gases, chemical fluids, water, etc., the trend is to automatic valves, but many are also equipped with lever or handwheel devices for auxiliary handwheel operation. Such combinations are available on Rockwell Valves in all sizes to 72".

Rockwell Valves are built in all metals and rubber-covered for operation to 100 p.s.i. from sub-zero to high temperatures.

Get our Valve Catalog—and ask to receive "Rockwell Valve News" monthly

This 30" pipe size Rockwell Butterfly Valve for 60 p.s.i. operating pressure is equipped with a Phillie Gear Limitorque Motor Control plus a handwheel for emergency manual operation. When installed, two indicating lights show fully open and fully closed position.

ROCKWELL SINCE 1888 BUILT

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Slide and Butterfly Valves • Steam Traps • Oil Burners

250 Eliot Street • Fairfield, Conn.

ADVERTISERS

in the April, 1951, issue of

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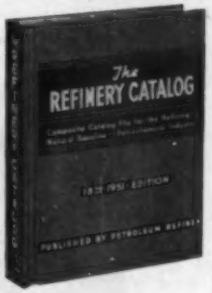

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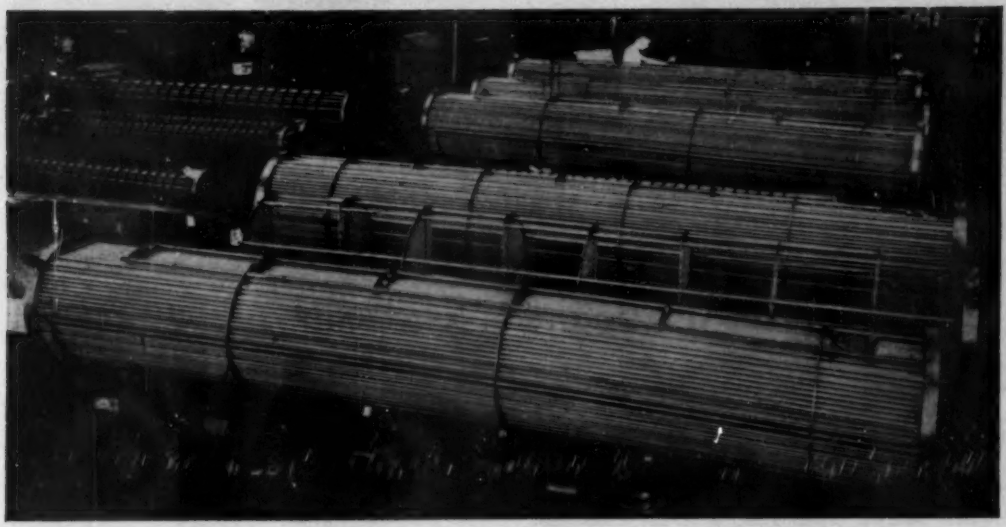

• Because each condenser installation presents an individual combination of conditions, let no one tell you that any one alloy is best. Every factor should be studied before deciding on the proper alloy. In some cases, Revere Admiralty tubes may be the most desirable. In others, aluminum brass might be preferred. Where brackish or salt water is encountered, cupro-nickel tubes usually are advisable. It all depends on the economic factors and conditions of service.

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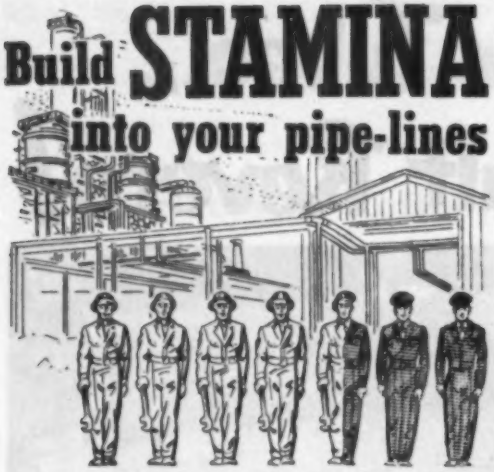

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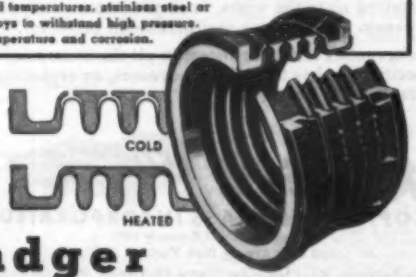

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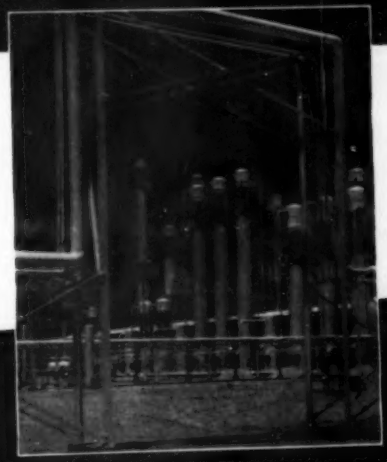

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